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Editor: D. B. Finn

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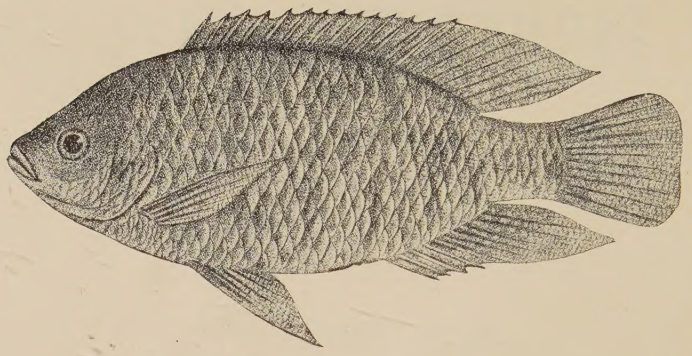
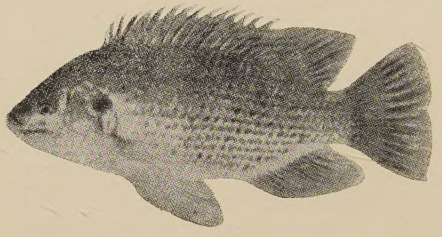
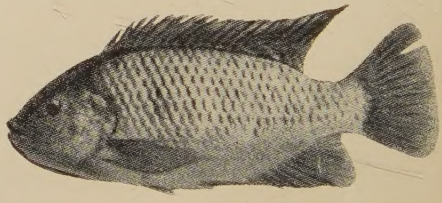


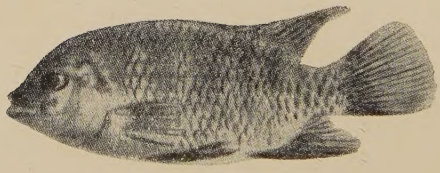
Tilapia mossambica (Peters)



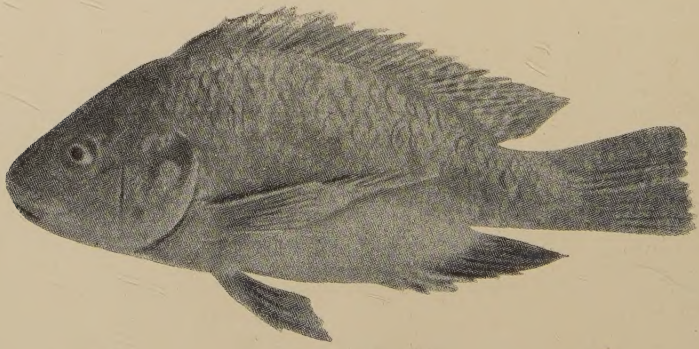
Tilapia machrochir

Tilapia melanopleura





Tilapia sparmanni



Tilapia nilotica

TILAPIA AND ITS CULTURE [1]

A Preliminary Bibliography

Introduction

Besides the exploitation of natural inland waters (fishing), the exploitation of artificially retained waters (fish culture) has been practised for a long time in Europe and Indonesia and for thousands of years in China. In Europe, the common carp ; in China, the group of Chinese carps ; in India, the Indian carps ; in Indonesia, the European and Chinese carps ; and Chanos in brackish waters, are the species which constitute, together with several others of lesser importance, a material which is traditional and proven for fish culture in inland waters and whose importance is constantly increasing because of the world's great needs for protein foods.

Since World War II a new fish, Tilapia, has appeared among the tools of trade of fish culturists and has provoked keen interest everywhere ; it has made prodigious progress in fish culture in warm waters and there are great expectations for it as a new source of protein food. This phenomenal appearance derives partly from the fact that all the *T. mossambica* distributed in open and closed waters of Indonesia, America and Asia come from five specimens found by chance at the end of 1939 at Papungan, near Kediri, in East Java (79). It is certainly the best example of intentional distribution by man of a species which is at once wild and domestic. But the great qualities of Tilapia, nevertheless, should not cause it to be regarded as a miraculous fish whose introduction everywhere could only be beneficial and represent the ultimate in hydrobiology and fish culture. Although the enthusiasm for this species must be brought into more normal proportions, the species will, nonetheless, still be of great importance because the rearing of Tilapia which can have great extension in tropical countries, affords an important source of protein food from cultivation as well as from open waters, from fresh waters as well as brackish, and it can contribute to the control of mosquitoes.

There are numerous species of Tilapia whose qualities, however, are widely different ; according to Boulenger [1909-16, (18)], there are 94 species and others have since been found. While a good understanding of the biology, ecology and cultivation of three species of the genus Tilapia (*T. mossambica*, *T. melanopleura* and *T. macrochir*) has been gained, practically all the other species are as yet insufficiently

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[1] By Pierre Chimits, Ing. des Eaux et Forêts, Ministère d'agriculture, Paris, while engaged as consultant with FAO, Rome, Italy.
The introductory text is a summary of information drawn from the papers listed and abstracted. It contains no opinions of the abstractor.
Ed. Note. The five species of Tilapia illustrated opposite are not to scale. Illustrations by courtesy of *Traité de pisciculture* ; *Pedoman Perikanan Air Tawar*, and *Bull. agric. Congo belge*.

TABLE 1 - PRINCIPAL SPECIES OF THE GENUS TILAPIA, CICHLID FAMILY, OF THE PERCOMORPHOUS ORDER

Species	Area of Origin	Food	Length and Weight				Incubation	Culture
			Maximum		Min. for Consumption			
			cm.	*g.*	*cm.*	*g.*		
T. mossambica	E. and S. Africa as far as Natal	Omnivorous (mainly algae and detritus	36	700	20	150	Buccal by female	Asia, Indo-Pacific, Antilles
T. melanopleura	W. Africa from Senegal to Angola	Phytophagous	40	1 300	20	150	Non-buccal ; fry guarded by female	Belgian Congo, Nigeria, French Equatorial Africa
T. macrochir	South of Central Africa (Zambesia) and Bangouelo and Moero Lakes	Planktonophagous and microphagous	40	1 200	22	150	Buccal by female	Combined with *T. melanopleura*
T. nigra	Kenya, Uganda	Omnivorous and phytophagous	—	—	20	150	Buccal by female	Kenya (of little importance)
T. andersonii	Rhodesia, Zambesia	Phytophagous	36	700	20	150	Buccal by female	None. Experiments in the Belgian Congo. Can cross-breed with *T. macrochir*
T. nilotica	Galileae, Jordan and Lake Tanganyika	Omnivorous	50	2 500	35	900	Buccal by female	None. Experiments in Nigeria and French Equatorial Africa
T. sparmanni	Southern Africa from Angola and Katanga	Omnivorous and phytophagous	20	150	15	60	Non-buccal ; fry guarded by male	None. Used as forage fish
T. galilaea	From Galileae and Jordan to Nigeria (Nile and Senegal)		—	—	—	—	Buccal by female	None. Experiments only in Nigeria and French Equatorial Africa
T. esculenta	Lake Victoria	Planktonophagous	38	800	30	500	Buccal by female	None

known, notably in respect of their ecology and the possibility of cultivation. It is, therefore, uncertain that these species are the best in all circumstances. Moreover, the techniques of cultivation of Tilapia, dating from World War II, are too recent to be established.

There is here a great field of research for biologists and fish culturists who, in recent years and in many countries, have directed their attention to this completely new problem of Tilapia. It is to assist them in their task and to contribute a comprehensive documentation for their use that this work, based on almost 100 scientific papers, has been undertaken. It also aims at emphasizing the fact that the introduction of Tilapia into a country must be based upon the conclusion of hydrobiologists who have studied these problems and should not be the result of the ill-considered enthusiasm of amateurs. In general it may be stated that the suitability of exotic species ought always to be tested first before any introductions are made. If it should be found that no local species is suitable, an exotic species must be considered. One of the purposes of this paper is to assist in the task of selecting appropriate species for introduction — a task which should include comparison of the qualities of various species of fish, including those of the genus Tilapia.

I. Tilapia in Open Waters

1. In its Area of Origin – Africa

The genus Tilapia, with about 100 species, originated in Africa and now extends north to Israel and Jordan. Its speciation (the evolutionary process of formation of new species) in the various waters of Africa has been the object of numerous researchers, notably British (26, 34, 54, 90, 91). Tilapia is present in almost all the inland waters of Africa, and since these waters supply half the animal protein foods of Africa, and as also the greater part of this supply consists of Tilapia, the present economic importance of the group is apparent.

In Egypt, 70% of the fish catch comes from inland waters, and 30% from the sea. The Egyptian lakes produce 30,000 tons of fish per year, of which Tilapia (*T. nilotica*, *T. zilii* and *T. galilaea*) represents from 60% to 80% (29, 1949).

In the great lakes of Central and East Africa where, moreover, the number of species of this genus is greatest, Tilapia represents by far the most important part of the fishery. Lake Nyasa has a yearly production of 3,000 tons of Tilapia (*T. lidole* and *T. squamipinnis*) (70). Possibly 30,000 tons, including other genera, could be produced from Lake Victoria (*T. esculenta*) and Lake Tanganyika (*T. nilotica*) ; Lake Albert (*T. nilotica*, *T. galilaea*) produces 4,000 tons, Lakes Edku and George (*T. nilotica*) 3,000 tons, and Lake Tchad (*T. galilaea*, *T. nilotica*, *T. zilii*) 30,000 tons.

Some figures of the yield from African lakes are given below :

TABLE 2 - FISH YIELD FROM AFRICAN LAKES

Lakes	Total Yield per ha. p.a.	Tilapia Yield per ha. p.a.
	kg.	*kg.*
Victoria	1.6	1.0 (approx.)
Tiberias	40.0	7.5
Nyasa	—	17.0
Karun (Egypt)	104.0	83.0
Edku (Egypt)	285.0	170.0

Production from the open waters of the Belgian Congo is estimated at 38,500 tons per year (37), and that of French Africa at 110,000 tons per year. A good part of this production also consists of Tilapia.

2. The History of Scientific and Technical Research on Tilapia

Research in Africa on Tilapia began about 1900 when Cunnington prepared an inventory of the inland waters ; this led to the work of Boulenger (18), which established the systematics of 94 species. Since 1927, interest has been taken in the ecology of the species (26, 34, 90, 91) and taxonomic work has continued in verification of earlier results and recording new endemic species [*see* the work of Trewavas (26, 34, 54, 70, 91)]. This research recently resulted in a monographic account of the biology of Tilapia (70, 71). Apart from the European scientific institutions (British Museum and the Muséum de Paris), there are now fish culture research stations in several African countries. Two African fish culture conferences have already taken place, the first at Elizabethville in 1949 and the second at Entebbe in 1952, at which the Scientific Council for Africa South of the Sahara, who sponsored the conference, established within its organization an inland fisheries section. At these conferences consideration of the fishing and cultivation of Tilapia took first place. [2]

3. Tilapia Fisheries and the Fisheries Services

Research on Tilapia undertaken by the African inland fisheries research stations relates to the systematics and ecology of the different species, fisheries statistics, estimation of the stocks and of their dynamics, the introduction of new gear, overfishing, utilization of fish, and predation and disease.

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[2] Elizabethville conference (*see* Nos. 4, 8, 9, 10, 14, 16, 17, 35, 41, 50, 51, 69, 84). Entebbe conference (*see* Nos. 19, 20, 22, 30, 37, 58, 64, 71, 72, 73, 91, 92).

Attention may be drawn to the following interesting points concerning Tilapia : the development of stocks of five species in Lake Nyasa as a function of water level ; the introduction of seines and gill nets has considerably increased the production from numerous underfished lakes ; under-exploitation is apparent (as formerly in Lakes Victoria and Nyasa) in the arrival of populations of old, malformed *T. esculenta*, with mediocre flesh and numerous bones. On the other hand, when it becomes evident that stocks are being overfished, a regulation minimum size of capture, with a limitation on the mesh of the nets, should be imposed to protect immature fish. The 5 in. (127 mm.) mesh [or 2.5 in. (63 mm.) between knots (90)] has most often been adopted for rational and balanced fishing of Tilapia in open waters as, for instance, in Lakes Victoria, Nyasa, Edward and George. Sometimes the spawning places of Tilapia, such as the marshes of Lakes Edward and George and the Kasinga Canal, have been protected from fishing.

The buccal incubation in Tilapia makes the capture of the female a serious matter, since the young fry abandoned by the captured female have little chance of survival. This is the case for *T. lidole* and *T. squamipinnis* in Lake Nyasa where, in December, great numbers of females are captured by nets. Tilapia is a gregarious fish which swims slowly in schools near the surface of the water, and is thus a prey to numerous predators, such as the crocodile, which must be destroyed or limited. Most pelicans (*Pelicanus roseus*), on Lake Edward, consume a ton of fish each year, of which the greater part consists of the adults of *T. nilotica* (76). In Lake Nyasa the numerous young Tilapia are consumed by predatory fish which can be captured by lines or cords, a method of fishing which should be encouraged to help the Tilapia.

So far no serious diseases or parasites of Tilapia have been recorded.

The most recent researches on ecology in the great lakes of Africa by the East African Fisheries Research Organization, Jinja, Uganda (26), indicate that the lack of sulphates in African soils and waters limits the production of plankton not only in quantity but, above all, in quality, which is serious for the planktonophagous Tilapia.

Marking has shown that, in lakes, Tilapia requires four years to reach sexual maturity, but this maturation is accelerated by exposure to full light, which explains the apparent sexual precocity of Tilapia in ponds and swamps (26).

Moreover, the herbivorous Tilapia feeds on plants deep-rooted in the mud which make use of nutrient materials inaccessible to plankton (26). The usefulness of introducing herbivorous Tilapia species to certain lakes (e.g. *T. zilii* in Lake Victoria) derives from this fact.

Papyrus swamps are bad for fish because their waters are deficient in oxygen and surcharged with carbon dioxide, but water lily swamps are good and Tilapia can spawn there. The productivity of a lake can, therefore, be increased by clearing the weeds from part of a papyrus swamp and by transforming other parts into well drained gardens (26). In effect, the ooze of these swamps contains a good part of the richness

of the African soil washed away by erosion, and drainage of the swamps will directly improve the richness of the lake plankton.

These notions, brought to light by recent work of the British fish cultural research programs in the African great lakes (26) should not be lost sight of in programs of managing open waters and especially in the introduction of new species of Tilapia.

4. The Acclimatization of Tilapia in Open Waters

Transport. Tilapia is a robust fish which, with minimum respiratory requirements and with heat endurance, can be carried easily over short distances, without special precautions, in simple water containers. Reports of transportation over long distances mention neither difficulties, special precautions, nor heavy mortality on arrival, for any species of Tilapia.

Vaas (86) gives details of transport of *T. mossambica* over long distances in sealed containers of the jerry-can type with oxygen under pressure ; he cites four experiments in which the transport varied from 24 hours to 244 hours and in which the success was 100%. Vaas has confirmed for *T. mossambica* the general relation : time of journey multiplied by total weight of fish = a constant, C. It is easy to furnish oxygen necessary for the transport of fish by means of cylinders of compressed gas, but at the end of a certain time the pH of the water falls, the fish excreta accumulates, and thereafter the calcium and, above all, the carbon dioxide, increases, and ends by killing the fish. It is, therefore, useful to employ buffer solutions as, for instance, boric acid or acidic phosphates of sodium which absorb the carbon dioxide.

On the other hand, small fish consume proportionately more oxygen than the big fish, and Vaas has confirmed for Tilapia the time equation for transport already established for fish such as carp and tench : $NW^{2/3} T = C$ where N = the number of fish, W = the average weight of fish in grams, T = the time of transport in hours. For Tilapia, C has been found to be 11,400 to within 3% in the experiments, for a container of a given volume and oxygenation, and this formula permits the calculation of the number of Tilapia of a given mean size transportable with security during a given period. Under these circumstances of transport in containers with oxygen under pressure *T. mossambica* was introduced into Amboina, Borneo, Banka, Egypt and elsewhere.

T. mossambica has been carried by ship from Malaya to New York then by air from New York to St. Lucia, B.W.I., with a loss of two individuals out of a total of 450 small fish. The transportation of Tilapia thus presents no technical problems, and Tilapia have now accomplished a journey of two-thirds of the distance round the world from their original habitat.

(*a*) Tilapia mossambica

Since *T. mossambica* originates from the east coast of Africa it is not known how it came to be in Java, where it was found in 1939.

As shown in Table 3, [taken from Atz (2) – we have only changed the date of the introduction to Taiwan (Formosa) and indicated the presence of Tilapia in the open waters of Ceylon],

TABLE 3 - TIME-TABLE OF THE TRAVELS OF *TILAPIA MOSSAMBICA*

Introduced in	Coming from	Date	Manner of Introduction to Open Waters
Java*	?	1939 or before	
Sumatra	Java	,, ,,	
Bali, Indonesia	,,	1941	
Lombok, Indonesia	,,	,,	
Malaya*	,,	1943	Escape
The Celebes	,,	1944	
Taiwan* (Formosa)	,,	,,	Escape
The Moluccas	,,	1949	
St. Lucia, B.W.I.*	Malaya	,,	Direct release
Thailand*	,,	,,	Direct release
Trinidad	St. Lucia	,,	
Grenada, B.W.I.*	,,	,,	Direct release
West Borneo	Java	1950	
East Borneo	,,	,,	
Amboina, Moluccas	,,	,,	
Banka, Indonesia	,,	,,	
The Philippines*	Thailand	,,	Direct release
Jamaica, B.W.I.*	St. Lucia	,,	Escape
Barbados, B.W.I.	,,	,,	
Dominica, B.W.I.	,,	,,	
Martinique	,,	,,	
Sabang, Pakistan	Java	1951	
Ceylon*	Malaya	,,	Direct release
Haiti*	Jamaica	,,	Direct release
North Borneo	Malaya	,,	
Hawaii	,,	1952	
Dominican Republic	Haiti	1953	
Travancore-Cochin, India	Malaya	,,	

*Countries in which the fish has become established in the wild.

T. mossambica was introduced into the closed waters of certain countries ; it has also been acclimatized in open waters either by deliberate release or by escape from closed waters. It is probable that after a few years it will be seen in the open waters of countries where it was originally introduced to closed waters. Also in Taiwan, Tilapia has escaped, since 1946, from closed waters and has become a common fish in the open waters of the island (21).[3]

Tilapia was introduced directly into the open waters of Thailand, but without result except in the marshes because of the great number of predators (67).

[3] Dr. S. W. Ling points out in a verbal communication that the distribution in Taiwanese waters is subject to strong temperature limits.

In 1952, *T. mossambica* was introduced into Ceylon directly into free and closed inland waters. In 1953, in certain lakes Tilapia constituted 80% of the catch (94).

Introduced into Haiti in 1951, *T. mossambica* represents 90% of the catch of the open waters of the Artibonite Valley (66). It has been directly released in the open waters of St. Lucia and Grenada, while, in Jamaica, it escaped from ponds and colonized in the rivers.

(*b*) Tilapia melanopleura *and* Tilapia macrochir

These two species have been distributed throughout Africa since 1947 for cultivation in closed waters. *T. melanopleura* has been introduced into certain swamps and lagoons of the Belgian Congo ; its cultivation was also attempted in Madagascar in 1951, but apart from this it has not been introduced outside Africa.

(*c*) *Other Species of Tilapia*

No attempts to introduce African Tilapia outside Africa have been made apart from *T. nigra* in Madagascar. There is, moreover, little interest in introducing Tilapia fry into open African waters since endemic species exist everywhere.

However, certain isolated lakes have no Tilapia, and British experts have recommended the introduction of *T. esculenta* and *T. variabilis* to Lakes Nakavili, Kachiro and Kyanibalola (90), and *T. shirana* to Lake Kazuni. The introduction of *T. nilotica* to Lake Bungori at an altitude of 6,500 ft. (1,980 m.) failed. In 1948, *T. nigra* was introduced into French Equatorial Africa for fish culture and into Madagascar in 1951. It was considered worthwhile introducing Tilapia to certain lakes to occupy those ' niches ' (natural food levels) hardly used or not used at all by the endemic species. Thus, the Technical Fisheries Services of East Africa considers it desirable to introduce *T. zilii* (herbivore) to Lake Victoria, where there are *T. esculenta* and *T. variabilis* which are entirely planktonophagous.

II. Biology of the Principal Species Raised in Fish Culture

At present only three species are raised on a great scale, *T. mossambica, T. melanopleura* and *T. macrochir*, but attempts at cultivation have been made in Africa with other Tilapia.

1. *Tilapia mossambica* Peters [Synonym : *T. natalensis* (M. Weber)].

Distinctive characters of the species : D : XV/XVII/10-12 ; A : III/9-10 ; number of scales on the lateral line : 29-32 ; number of branchiospines of the first branchial arch : 14-19 (exceptionally 20).

Locality of origin and ecology. Indigenous to East and South Africa as far as Natal ; it has been successfully introduced in recent years in almost all the countries of the Indo-Pacific, tropical Asia and the Antilles.

A warm water fish for which the temperature optimum lies between 20° and 35°C. It is killed by a temperature of 10°C. and by a period of several days at 14°C. Above 38°C. it does not thrive well and it reproduces badly (21). In the Pacific, Taiwan (Formosa), latitude 30° N., is the northern limit it survives at present, and even so it is necessary in the northern part of the island to keep the spawner in wintering ponds.

It is euryhaline and thrives and reproduces equally well in fresh and brackish water up to 30‰ salinity. From 30‰ to 40‰ its growth is satisfactory, but it does not reproduce (87).

Reproduction. The female incubates the eggs in her mouth. The species is monogamous. Sexual dimorphism is visible to the naked eye on 6 to 7 cm. fish, and with a magnifiying glass from 3 to 5 cm. (87). The female has an oviduct between the anus and the urethra (three orifices), while the male has only two. Spawning can commence from the age of two or three months, the length being then from 8 to 9 cm.; the number of eggs produced at that age is 80, but this increases to 800 for a female of 15 cm. and then exceeds 1,000.

The couple dig a trench on the bottom 6 cm. deep and 30 to 90 cm. long where the eggs are deposited and fertilized. The female then takes the eggs into her mouth where they hatch in two or three days. Five to eight days later the fry have lost the vitelline vesicle and leave the mouth of the female. However, they return to take refuge at moments of danger for several more days.

The annual number of spawnings varies with the climate and the food. Spawning takes place during the warm season, when water temperature reaches at least 20°C.; it can thus continue throughout the year in equatorial regions. The number of spawnings is from six to eleven with an interval of from 22 to 40 days.

Dispersion. Apart from Africa, the dispersion of *T. mossambica* began in 1939 in East Java. It was immediately propagated by man in the numerous brackish-water ponds of Java, since the war prevented the restocking of these ponds with Chanos fry. At the same time it has colonized the open waters of Java. During the war the Japanese introduced this species to the greater part of the islands of Indonesia, Malaya and Taiwan (Formosa) for the purpose of food production. FAO and certain governments have also introduced the species to various countries, as shown in Table 3 (p. 7).

Nutrition. T. mossambica is an omnivore which feeds especially on plankton and vegetation. The young feed solely on plankton diatoms, green algae and small crustacea. The adult feeds equally on plankton, but also seeks filamentous algae, notably the chlorophycae (which is of interest in connection with control of malaria), higher plants and decomposing vegetable matter. Beyond this it makes good use of artificial food, such as the waste of rice, soya, cocoa, various flours and oil cakes. Particularly in Thailand, bundles of Ipomoea, whose leaves are eaten by Tilapia, are placed in the ponds (67).

Growth. The male always grows more quickly than the female because of the long period of buccal incubation during which the female does not feed. It is interesting to note, for the purpose of cultivation, that if males and females are separated the growth of the two sexes becomes similar ; this method, however, has not yet been put into practice. For this reason, under good feeding conditions, males and females raised together starting from the same individual weight of 4.5 g. at the age of two weeks reach, at the age of 14 weeks, a weight of 61 g. for the males and 24 g. for the females (87). Growth is then less rapid even under very good conditions. They reach a size of 18 to 20 cm. with a weight of 130 to 150 g. at the age of 10 months, and are then fit for consumption. The maximum size observed in fresh water is 36 cm. of about 700 g., but *T. mossambica* weighing 850 g. have been seen in the brackish water ponds of Singapore.

2. *Tilapia melanopleura*

Characteristics of the species : D : XV-XVI/12-13 ; A : III/9-11 ; scales 29-32 ; number of branchiospines of first branchial arch : 8-12. Belly, pectoral fins and ventrals and the lower part of the caudal fin tinged with red.

Locality of origin and ecology. T. melanopleura is indigenous to the western part of Africa from Senegal to the north as far as Angola, to the south to Bechuanaland and Zululand passing beyond the Congo and the Niger. It is widely cultivated in the Belgian Congo, French Equatorial Africa and the Cameroons.

A warm water fish, it dies if the temperature falls below 12° to 13°C. It reproduces only at temperatures above 21° to 23°C. (49). It inhabits fresh water and brackish water lagoons of the Gulf of Guinea and, although it is euryhaline, reaction to salinity has not yet been made the object of precise research (54).

Reproduction. The species is monogamous and without buccal incubation. Sexual dimorphism is the same as in *T. mossambica* (three ano-genito-urinary orifices in the female, and two in the male), but the genital opening in the female is prolonged by a conical ovipositor which can reach a centimeter in length (the red color of the belly is much deeper in the male). It spawns at 7 months at a size of 12 cm. in French Equatorial Africa (28), at 15 cm. in the Belgian Congo, and at 20 cm. in the High Katanga (altitude 1,200 m.) (49). In the equatorial region of French Equatorial Africa it spawns all the year round at 6 or 7 week periods. Otherwise it spawns only when the temperature of the water reaches 21° to 23° C. and then it has four spawnings as in the Belgian Congo, each of 5,000 to 6,000 eggs. In the Belgian Congo, the yield from the harvest of fry is 33 %, or 7,000 to 8,000 fry per female per year. The male constructs the nest on the slopes of the bottom or of the bunds, at a depth of 10 and 100 cm., with 5 to 10 holes of 10 cm. in diameter grouped on an area from 50 to 75 cm. square. The eggs are deposited in

only one of the holes. After fertilization, the female alone guards the eggs. After hatching, from 15 to 20 days, the female moves the fry from one hole to another, probably in order to confuse predators.

Dispersion. Apart from its locality of origin, *T. melanopleura* was introduced to Madagascar in 1951 (73) ; its cultivation, greatly extended in the Belgian Congo since 1947, has been developed in numerous ponds in French Equatorial Africa and the Cameroons.

Nutrition. Feeds exclusively on plants. From the fry stage to a size of 3 to 5 cm. it feeds on phytoplankton and unicellular algae grazed from the reeds and the bottom, but excluding zooplankton. Thereafter, it feeds more and more, up to 90%, on filamentous algae and higher plants [Sparganium, Lagarosiphon, Potamogeton, Hydrilla, Leersia, Chara (14), Carex, Typha (11)], but excluding Vallisneria and Nymphaea. It clears ponds of their vegetation with remarkable efficiency. It eats artificial food only after a size of 4 cm. (mill wastes, leaves cut from banana trees, manioc, sweet potato, couch grass, paspalum) with an excellent yield of 1 kg. of fish for approximately 5 to 7 kg. of artificial food.

Growth. Under good conditions growth is very rapid at the beginning and reaches 5 to 6 cm. at six weeks, 14 cm. and 50 g. at six months. Growth then slows down ; by culture methods it is expected to produce fish of 20 cm. and 150 g. at the age of 10 to 11 months as in the Belgian Congo (49). Old individuals reach a maximum length of 40 cm. and 1,300 g.

3. *Tilapia macrochir*

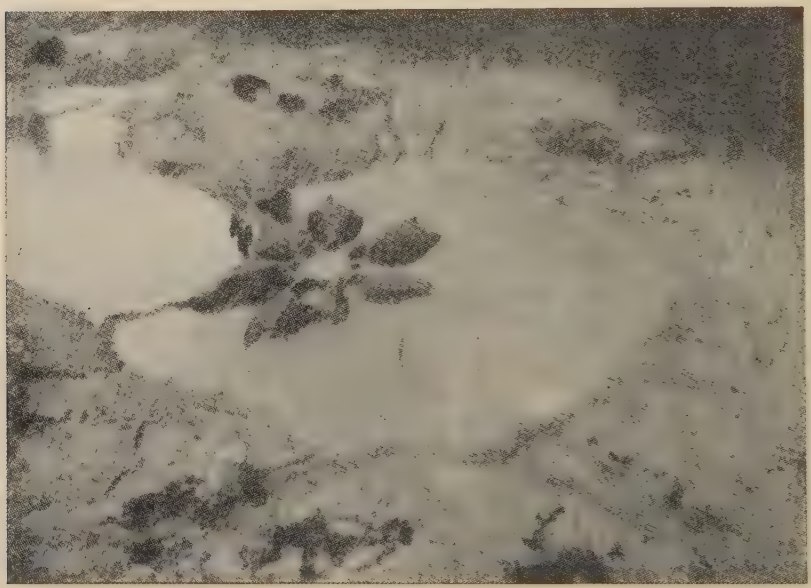
Distinctive characteristics of the species : D : XV-XVI/11-13 ; A : III/8-11 ; scales 29-31 ; number of branchiospines of the first branchial arch : 21-25.

Locality of origin and ecology. Indigenous to the southern part of Central Africa (below Zambesia) and to Lakes Bangouelo and Moero.

A warm water fish killed by a temperature of 12° to 13°C. and reproducing in water from 21° to 23° C. (49). Solely fresh water in its natural habitat, its reactions to salinity have not yet been studied.

Reproduction. Monogamous, the female incubates the young in her mouth. Sexual dimorphism, apart from the existence of three anogenito-urinary orifices in the female and two in the male, is displayed by a genital papilla in the male which is well developed into long divided filaments which can reach a length of 5 cm. The female has a silvery color with creamy yellow head ; the male is darker, the lower part of the head carrying some black spots. It reproduces at 8 months at a length of 14 cm. in French Equatorial Africa (29), and at 20 cm. in the High Katanga and at 10 to 11 months in the Belgian Congo (49). In the equatorial regions it spawns eight times a year, that is, every 6 or 7 weeks (28), and in the Belgian Congo it gives 5

to 6 spawnings, one every four or five weeks, in the rainy season only. Each female above a size of 20 cm. produces 1,000 to 1,500 eggs at a spawning with successful production of 60% and thus 4,000 to 5,000 fry each year [Belgian Congo (49)]. The male constructs a very characteristic nest on the bottom of the pond, at a depth of between 30 and 150 cm. The nest has a large diameter (50 to 300 cm.) consisting of a central basin 20 cm. in diameter, surrounded by a rim pierced with small holes from which spring, like rays, 6 to 10 earth ridges (49). After spawning in the nest and fertilization, the female sucks the eggs into her mouth and incubates them there. After absorption of the vesicle, the fry leave to feed, but at the least sign of danger, during a period of 15 days, they return again to the mother's mouth.



A nest made by *T. macrochir*. No vegetation remains near it (Courtesy *Bull. agric. Congo belge* 41 [2])

Dispersion. Apart from its locality of origin, *T. macrochir* has been much cultivated, simultaneously with *T. melanopleura*, in the Belgian Congo since 1947. It has been distributed in the rearing ponds throughout French Equatorial Africa and the Cameroons, and was introduced into Madagascar in 1951 (73).

Nutrition. Feeds essentially on plankton of microscopic dimensions. It feeds exclusively on plant plankton and on micro-organisms, grazed from plants and from the bottom. After a size of 4 to 5 cm. it begins to take artificial food (mill wastes, flour and oil cakes) which can constitute 50% of its food supply, and at a length of 12 cm. 70% and upwards. Oilcakes, flours and chemical fertilizers equally promote its growth by the multiplication of the plankton.

Growth. Like *T. melanopleura*, its growth is rapid at the beginning : 6 to 7 cm. at six weeks : 14 cm. and 50 g. at six months. The rate of growth then decreases slowly, 29 to 22 cm. and 150 g. at 10 to 11 months, and thereafter decreases rapidly. The heaviest individuals do not exceed 40 cm. and 1,200 g. The male grows more quickly than the female, in a proportion of 1.4 : 1 (28), because of the drain of buccal incubation.

III. Methods of Raising Tilapia

Although recent, these methods for obtaining fry and fish for consumption are already numerous, and though simpler than the methods for carp, they are all based upon the following facts :

(*a*) Tilapia can live in very crowded conditions in a pond without any effect on its growth or reproduction ;

(*b*) each age class has different feeding habits and all can live together independently without interfering with one another ;

(*c*) a good yield can be obtained only after a heavy initial stocking;

(*d*) fertilizers and artificial foods give excellent results ;

(*e*) the growth of Tilapia is very rapid at the beginning, but slower later on. It is necessary, therefore, to remove as many as possible of the fish which have reached marketable size by regular intermediate fishing operations before finally emptying the pond.

It is as well, also, not to forget the following :

(*i*) Tilapia reproduces when it is very young and it reproduces constantly. Its reproduction, therefore, is difficult to control and may result in populations of pigmy-sized non-marketable fish.

(*ii*) The growth of the sexes is different.

The fish culture methods for Tilapia can be classified according to the species raised, according to the methods of obtaining fry (governmental fish culture stations) and according to methods of obtaining marketable fish. There is a general tendency in tropical countries to consider the cultivation of Tilapia as a family operation for food, under the same heading as poultry, pigs and the vegetable garden.

Regarding the construction of ponds for Tilapia and their accessories (outlet towers, fisheries), the reader is referred to various Belgian authors and especially to Huet (49) and to Tung-Pai Chen (21) on the cultivation of rice fields.

1. Methods of Rearing *T. mossambica*

T. mossambica can be raised equally well in closed waters as in brackish waters where it reproduces normally as long as the salinity does not exceed 30‰.

Thai Method. The spawning pond of the family type is 50 m^2 in area, with a depth of 0.50 m. and is stocked with 20 pairs of fish. The communal spawning pond is of variable dimensions, but of an area of 1,000 m^2 with a depth of 0.5 m. and sufficient to furnish fry for 20 families as well as a quantity of marketable fish. These spawning ponds are placed in the immediate proximity to the growing ponds.

Methods of procuring fry. This method was established in 1941 by the Javanese fish culturist, Djaeni (87), and is based on the rapid separation of the fry from their parents.

A spawning pond about 150 m^2 is situated at a level slightly above that of the first fry pond which is five times larger. The spawning pond must be in a quiet place because the Tilapia take fright easily, and it should have an abundant aquatic vegetation (*Hydrilla verticillata*), a loose bottom (for the spawning holes) and a depth of 40 cm. upstream by 70 cm. downstream. Artificial food (rice waste) is added to the two ponds. Twenty spawners (three females to two males) are placed in the pond at the beginning of spawning which is indicated, apart from the appearance of spawning holes, by the fact that the spawners keep themselves hidden.

Fifteen days after the beginning of spawning, the pond is slowly emptied into the first fry pond. The spawned parents spit out the fry which are carried with the water into the lower pond while they themselves remain in the spawning pond, which is then refilled. Six weeks later all the fry can be harvested with three age classes of 2, 4 and 6 weeks, measuring 3, 5 and 8 cm. (68).

2. Methods of Procuring Marketable Fish

(*a*) *In Fresh-water Ponds*

Rural Family Method. This is the simplest. A number of Tilapia of all sizes are placed in a simple hole or in a pool near a house where liquid manure or dung of domestic animals, and flour and kitchen waste can easily be emptied into it. The owner fishes this pond, according to the needs of his family, with line, trap or net, the fish having reached the desired size. From time to time the pool is emptied and after collecting the best fish, the pond is filled again and restocked with the small fish.

Thai Method (67). This method of farm fish culture is highly developed. The family type of pond has an area of 4 ares and a depth of 0.50 m. with a minimum of 0.30 to 0.40 m. It must be closed off with a bamboo grid to exclude predators and to prevent the escape of the Tilapia. The undesirable plants (lotus and water lily) are eliminated and the predators are destroyed by fishing, quicklime and derris. In this case the Tilapia are not introduced until ten days later. The pond is then heavily fertilized with manure (pig, cattle, poultry) at the rate of 5 kg. of animal manure, well distributed, every four or five days, for a pond of 4 ares, for the maintenance and

growth of plankton and aquatic algae. A supplementary quantity of fertilizer is added every 20 days. A compost of garden material and leaves is placed in two heaps, projecting above the level of the water, in two opposite corners of the pond ; these are added to regularly and are held in place by some bamboo rods. The pig pen, poultry run and garden are located in immediate proximity to the pond, both for ease of transport of the manure and for running in liquid manure. A bush of Ipomoea (which must not cover more than 1/20th of the surface area) is planted in a corner and furnishes food for the Tilapia, the pigs, the poultry, and even for man. Finally, abundant artificial foods (rice, oil cake, cocoa, and mill wastes) are placed in the pond, but always at the same, limited space. The richness of the plankton in the pond is shown by green coloration of the water. The initial stocking per are consists of 18 to 10 spawners and 25 to 40 fry of at least 8 cm. and can be made at any time of the year, except perhaps in the very hot season. The fish are placed carefully in the water, either in the morning or late in the evening. Spawning takes place rapidly, and the stocking limit is quickly reached ; it is then necessary to remove some of the adult fish by netting every 15 days. The annual yield is about 40 kg. per are, or 4,000 kg. per ha.

Between the rural family method and the perfected Thai method, every intermediate grade is possible. For example, in the method used in Malaya (59) the average pond is 30 × 15 m. and 1 m. deep, and is stocked with 1,000 fry of 5 cm. Manure and artificial foods (wastes of rice, copra oil cake, chopped tapioca leaves) are regularly added. The Tilapia reproduce at 10 cm. and since the growth rate diminishes greatly toward 12 to 14 cm. with a weight of about 50 g., the pond is fished regularly. The yield in Malaya is from 800 to 900 kg. per ha. with fertilization and without artificial feeding.

(*b*) *In Brackish-water Ponds* (*Tambaks*)

Mixed culture (79, 87). The brackish-water ponds of Indonesia (tambaks) which, until just before the war, were used solely for the production of Chanos and shrimps, can be stocked with Tilapia which eat the filamentous green algae, thus destroying mosquitoes. There is an increase in the total yield of fish, but a reduction in the yield of Chanos and shrimps which are of considerably greater value on the market than Tilapia. This mixed cultivation is practised only in those brackish-water ponds which are very rich in green algae and other vegetation.

Pure culture. In Indonesia (87), and in Malaya (59, 60), certain tambaks are stocked only with Tilapia. Because of the rapid reproduction of Tilapia, and to avoid overstocking, professional fishermen fish these ponds with nets every two or three weeks retaining a proportion of the catch for themselves. The yields reach about 450 kg. per ha., but in Malaya can reach 1,100 kg. per ha. with manure, but without artificial feeding. The yield in brackish water is thus slightly higher than that in fresh water (800 to 900 kg.)

(c) In Rice Fields

Rice fields can be used equally well for the culture of carp and Tilapia and with the latter give yields of 200 to 300 kg. per ha. without interfering with the rice harvest.

Certain authors consider that Tilapia lowers the yield of rice by 10% (21), the creation of ditches having reduced the area actually cultivated for rice ; others consider that Tilapia increases the rice yield by 5 to 15% by the destruction of insects harmful to rice, while reducing the work of removing the undesirable weeds, which the fish eat (21, 68).

The great area of rice fields, almost always situated in over-populated regions, gives a great importance to this aspect of the cultivation of Tilapia as a form of cultivation secondary to rice.

Some adjustment of the rice field, sometimes a little expensive, is necessary. The bunds must be reinforced, enlarged, and must carry, all round the pond, a small footpath on the outer side, and on the inside a ditch from 0.3 to 1 m. deep, 1 to 2 m. wide. If the rice field is larger than 1 ha., a small bund 15 cm. high and 0.30 m. broad limits the ditch, and the area planted with rice is crossed by two shallow gutters to facilitate the movement of the fish. The method is described in detail by Tung-Pai Chen (21).

Taiwanese Method (21). Ten days or less after planting out the rice and when the water passes 15°C., the rice fields are stocked with Tilapia at the rate of 7,000 to 8,000 fry or 150 kg. of fingerlings per ha. Manure (2,000 kg. per ha.) or compost (3,500 kg. per ha.) is spread and artificial food is supplied in the form of wastes of rice or soya (10 to 20 kg. per day per ha.) when the stocking becomes heavy.

The big fish are collected at the first rice harvest. Short, hard-stemmed rice is planted out and all the fish are removed after the second rice harvest. The inedible fish are kept as fry or given to ducks.

Thai Method (68). Fertilizers are spread as for rice cultivation but with a 20% supplement.

The rice field is stocked either three weeks after planting out the rice and with 18,000 to 25,000 fry of 2 to 4 cm., or four weeks after planting with 12,000 to 15,000 fry of 5 to 6 cm. After six weeks a supplement of 25% of organic manures can be added. If chemical fertilizers are used (with the exception of products toxic to fish, such as calcium cyanamide) the water level is lowered to evacuate the fish into the ditch and the water level is restored two days later. Six weeks after stocking, artificial food (rice waste, oil cake, grasses) can be distributed every two days at the rate of 1% of the weight of fish to be harvested, but without exceeding this rate.

With the rice harvest the fish are also harvested from the ditch by means of landing nets or small seines, with subsequent intermediate harvests of the bigger fish at periods of low water.

Indonesian Method (48). The rice field is stocked with Tilapia of 3 to 5 cm. ; these fish very soon reach 50 to 100 g. at which size they

are marketable. This represents a theoretical yield of 300 kg. per ha. per year.

During the 40 to 60 days separating the second planting of rice from its flowering, 30 to 50 kg. of fish can be produced, and the rice harvest can be increased 7%.

Where only one rice crop is obtained each year, Tilapia is raised after the rice, the field being transformed into a pond.

Tilapia can also be raised during the fallow period of two to four months before the cultivation of rice.

3. Method of Cultivation of *T. melanopleura* and *T. macrochir*

These two species are at present cultivated only in the Belgian Congo, French Equatorial Africa, the Cameroons and in certain ponds in East and South Africa. Cultivation takes place only in ponds and has not been tried either in rice fields or brackish waters. The two species have different feeding habits and are raised together in various proportions according to the abundance of vegetation which is eaten by *T. melanopleura*.

Yields exceeding 9,000 kg. per ha. have been reported (13, 49) with use of fertilizers and artificial food and these are greater than the yields obtained in Indonesia with *T. mossambica* alone, but in poor ponds without fertilization or artificial food, the yield can be ten times less or even lower. Several methods have been tried, but the 'mixed' method tends to be used more and more frequently. The artificial food consists of mill wastes, oilcake, and various cotton grains for *T. macrochir*, and chopped leaves for *T. melanopleura*. In the mixed method one can give up to 90 kg. of food per ha. per day with a yield of 1 kg. of fish from 5 to 7 kg. of food.

Method of cultivation (49). *Dubisch Type.* As for carp, three or four types of ponds are used for spawning, for first and second lots of fry and for growth.

The spawning pond has an area of 12 to 20 m^2 with a depth of 0.21 m. into which a single pair of spawners is placed. The fry are collected by a landing net when they are abandoned by their parents (at two to three weeks, size 3 cm.).

T. macrochir spawn on the bottom of the pond, and *T. melanopleura* on the slopes, so that these surfaces must be flat. Aquatic plants are removed to facilitate the capture of fry and the spawners are fed with artificial food.

First fry pond. This has an area of 1 to 5 ares. It is flat and shallow and stocked at the rate of 1,000 to 1,500 per are. At the end of six weeks the Tilapia grow from 3 cm. to 6 or 7 cm.

Second fry pond. This is larger than the preceding pond and receives 6 to 7 cm. fry which are two months old, retaining them until they are six months old when they will be 12 cm. The original stocking is from 100 to 150 fry per are and can be raised to 700 fry if there is artificial food.

Growing ponds. These are from 0.25 ha. to 2 ha. with a depth of 0.5 m. upstream to 2 m. downstream. The stocking rate is calculated as for carp with production estimated at, for example, 1,200 kg. for four or five months use of the pond, and a harvest of edible fish of 20 cm. (150 g.) aged 10 to 11 months.

The method is excellent, but too complicated and can be used only in government fish culture stations.

Method with breeding ponds (49). This begins with spawning couples stocked in the pond at the rate of one pair per are if cultivation is intensive, or one pair for 15 ares if it is extensive ; the pond is emptied at 10 to 11 months, but intermediate fishing takes place. The method is sparsely applied because the pond is poorly used during the first part of the rearing.

Mixed Method (6, 7, 13, 49). This method is based on the principle that the maximum yield is obtained from heavy initial stocking of fish of all sizes and by frequent intermediate fishing.

In the Belgian Congo where the waters are rich, stocking can reach 1,000 to 1,500 kg. per ha. of fish of all sizes, fry and spawners. The operation begins with releasing *T. melanopleura* in numbers depending upon the richness of the natural vegetation, but no more than 1,000 fry per ha. except with artificial food and green vegetation ; the rest of the stocking to reach, for example, 1,200 kg., will consist of *T. macrochir*. After three or four months, regular fishing begins with line, trap or nylon gill net of all fish above 15 cm. and the pond is emptied 8 to 12 months after initial stocking. Fish are placed in a tank with a separating net while fish ready for consumption are selected and placed in a holding pond and the fry are used to restock the ponds.

This method is the one most generally employed ; it is very simple, gives an excellent yield and is within the reach of the local inhabitants.

In French Equatorial Africa the method is a little different from the Belgian Congo method (28). The waters are poorer and warmer. In the first instance, for a pond typical of the region, the optimum initial stocking of kg. per ha. must be determined, as well as the growth curve of the population, to ascertain the maximum stocking of the pond beyond which the yield falls greatly. Intermediate fishing is carried out and the pond is emptied as soon as the final maximum is reached. In the middle regions of the Belgian Congo, the best yield is obtained from initial stocking of 500 kg. per ha., the final stocking being 2,000 kg. Regular removal of fish by line and net is effected daily. Food is given every two days and the pond is emptied at the end of six months when the final maximum stocking of 2,000 kg. has been reached. The pond is immediately restocked with 500 kg. This method allows two seasons per year.

(1) ARONSON, L.R. An Analysis of Reproduction Behavior in the Mouthbreeding
1949 Cichlid Fish, *Tilapia macrocephala* (Bleeker). *Zoologica, N.Y., 34* (1-20): 133-158.

After surveying present knowledge on the subject, the author states that among Tilapia only 4 of the species do not incubate the young in the mouth. Reproduction is carried out as follows: 1. in some species buccal incubation takes place by the female; this is the most frequent case; 2. in some, buccal incubation takes place by the male; 3. in some, by both sexes; 4. there are some species in respect of which authors contradict one another.

From aquarium studies of *T. macrocephala* (Bleeker), endemic to W. Africa (Gold Coast), details are given on 3 stages of sexual behavior: (*i*) preparatory stage or sexual parade; (*ii*) spawning stage (preceded by construction of the nest); (*iii*) stage following spawning with buccal incubation, normally by the male, accidentally by the female.

(2) ATZ, J.W. The Peregrinating Tilapia. *Anim. Kingdm. 57* (5): 148-155, illus.,
1954 table, bibl.

A table gives the precise dates of the introduction of *T. mossambica* into 28 countries of the Far East and America. The Alabama Institute is studying the possibility of acclimatizing Tilapia to the warm waters of the U.S.A.

(3) BARNARD, K.H. Revision of South African Cichlidae. Synonymy and Notes on the
1948 Species. *Report* No. 5, Director of Inland Fisheries, P.O. Box 152, Stellenbosch, Union of S. Africa, pp. 48-61.

The revised Tilapia fauna of S. Africa consist of *T. mossambica, T. melanopleura, T. sparmannii, T. andersonii, T. kafuensis* and *T. macrochir*. Specific and anatomic characters given together with ecology and distribution.

T. nigra, T. shirana and *T. squamipinnis* are not found in S. Africa but are neighbors and could be introduced.

(4) BEAUCHAMP, R.S.A. The East African Inland Fisheries Research Laboratory,
1950 Jinja (Uganda). *Comptes rendus de la Conférence piscicole anglo-belge, Elizabethville* (*Congo belge*) 13 - 18 juin 1949. Directions de l'Agriculture du Ministère des Colonies et du Gouvernement Général du Congo Belge, Brussels, Belgium. pp. 46-50, illus.

The Laboratory studies the Tilapia of Lake Victoria where it is the most important fish. The studies also cover growth rate and the sexual cycle from the point of view of culture.

(5) BODENHEIMER, F.S. Über die Geschlechterfrage bei maulbrütenden Cichliden.
1927 *Zool. Anz., 73*: 88-89.

The author confirms J. Pellegrin's view according to which, in Lake Tiberias, only the female of the *T. galilaea* and *T. simonis* practises buccal incubation.

(6) BONT, A.-F. de. Techniques de pisciculture actuellement utilisées au Congo
1949 belge. *I.R.S.A.C., Deuxième rapport annuel*, Imprimerie Marcel Hayez, 112 rue de Louvain, Brussels, Belgium, pp. 161-194, illus., bibl.

Among the various species raised by fish culture in the Belgian Congo, *T. melanopleura* and *T. macrochir* are the principal, while *T. nigra* and *T. christii* are of subsidiary interest north of the Congo.

The author describes the method of obtaining fry from spawning ponds with one or more spawning couples and capture of the fry with a fine meshed net. The mixed method of rearing fish for consumption is also described: a large number of spawners of the species (*T. melanopleura* and *T. macrochir*) are placed in a pond, and when the fish reach 15 cm. they are fished daily by net, trap or line, and the pond is emptied either 6 months or 2 years later. This is the easiest and most practical method.

(7) ————. Rapport annuel 1947/1948 de la Station de recherches piscicoles.
1950 *Bull. agric. Congo belge, 41* (2): 473-538, illus.

The temperature of rearing ponds for Tilapia ranges from 13° to 26° C. These ponds have been fertilized and supplied with flour waste and have given annual yields from 937 kg. to 5,135 kg. per ha. with non-selected, indigenous Tilapia.

(8) Bont, A.-F. de Aménagement piscicole des étangs. *Comptes rendus de la Conférence piscicole anglo-belge, Elizabethville, (Congo belge)* 13-18 juin 1949. Directions de l'Agriculture du Ministère des Colonies et du Gouvernement Général du Congo Belge, Brussels, Belgium. pp. 265-272, figs.

Description of the management of ponds for rearing Tilapia. The best system of emptying the pond and catching the fish is given by an outlet tower and a sump.

(9) ———. Reproduction en étangs des *Tilapia melanopleura* (DUM,) et *T. macrochir* (BLGR.). *Ibid.*, pp. 302-312, figs., bibl.

The size of spawners is 20 cm. for *T. macrochir* and 22 cm. for *T. melanopleura*. Sexual differentiation is difficult. The male constructs the nest which, in the case of *T. macrochir*, is on the flat bottom and, with *T. melanopleura*, on the sloping embankments. Buccal incubation takes place only with *T. macrochir*, but for both species parental care of the fry is necessary. Spawning occurs only in the rainy season. In *T. macrochir* there are 6 spawnings of 900 fry each season, in *T. melanopleura* 4 spawnings of 1,800 fry each.

(10) ———. La culture des Tilapia. *Ibid.*, pp. 321-236, figs., tables.

For fry production in *T. macrochir* and *T. melanopleura* artificial fertilization must be rejected. A spawning pond can be operated with several couples or better with one couple in a pond 12 to 20 m^2 in area. Fry placed in a fry pond at 15 days can be transported and liberated at 2 months (length 6 cm.). For production of marketable fish the best ponds are those of $^1/_3$ or $^1/_2$ ha. The simplest method and the most adaptable for local people consists of stocking heavily with fish of all sizes and fishing regularly with line or net. The yield is increased by fertilization and artificial feeding.

(11) ———. La production de poisson de consommation. *Bull. agric. Congo belge, 43* (3) : 827-838, illus., tables.

Four ponds on a farm at Katanga have given yields of Tilapia from 3,290 kg. per ha. p.a. *T. melanopleura* eats all vegetation, even somewhat hard higher plants such as Typha and Carex.

Stocking should be heavy : 1,000 kg. per ha. of fish of all sizes. *T. melanopleura* should be released first, the number corresponding to the richness and to the nature of the aquatic vegetation, after which *T. macrochir* is released. Mill wastes are added.

(12) ———. La production de poisson de consommation au Congo belge. Méthode préconisée. *Ibid., 43* (4) : 1053-1068, illus., tables.

The author describes the mixed methods for combined cultivation of *T. melanopleura* and *T. macrochir*. There must be heavy stocking of fish of all sizes so as to reach a maximum quickly. Harvest takes place throughout the year by fishing with net or line, then by total emptying of the pond after 8 and 12 months. Fishes of less than 15 cm. are returned to the pond.

(13) ———. Rapports annuels N° 2 (1949) et N° 3 (1950) de la Station de recherches piscicoles à Elizabethville. *Ibid., 65* (1) : 157-184.

A study of the food habits of *T. melanopleura* and *T. macrochir* shows that feeding varies with age, and it is advisable therefore, to have a mixture of fish of all sizes if the best yield is to be obtained. The growth rate of the 2 species is reduced in the dry season ; the male grows more quickly than the female.

T. andersonii progresses more slowly and can cross-breed with *T. macrochir*. The pond yields of *T. melanopleura* and *T. macrochir* are from 2,250 to 9,300 kg., starting with a high stocking of fish of all sizes and feeding with mill wastes and leaves for *T. melanopleura* and fertilization with oil cake for *T. macrochir*. The method of rearing with several ponds and fish all of the same size in each pond has been abandoned. In the mixed method which is used 75 pairs of spawners per ha. are placed in the pond, and fishing with line or net with 4 to 5 cm. mesh takes place when the fish have reached 15 cm. The pond is emptied at 10 months.

(14) ———, Deceuninck, V., and Detaille, L. Régime alimentaire des *Tilapia melanopleura* et *T. macrochir* en étangs. *Comptes rendus de la Conférence piscicole anglo-belge, Elizabethville (Congo belge) 13-18 juin 1949.* Directions de l'agriculture du Ministère des Colonies et du Gouvernement Général du Congo Belge, Brussels, Belgium. pp. 293-302, illus., bibl.

After a study of stomach contents and growth curves, the authors give the feeding habits as a function of size. *T. melanopleura* is essentially phytophagous, *T. macrochir* is planktonophagous but also eats worms. As they grow older, both species can eat more and more artificial food (mill wastes).

(15) Bont, A.-F. de, Halain, C., Huet, M., and Hulot, A. *Premières directives pour*
1948 *l'élevage de poissons en étangs au Katanga. Pisciculture des Tilapia.* Directions de l'agriculture et de l'élevage, Ministère des Colonies, Brussels, Belgium. 24 pp., figs., illus. Price : Fr. 20.

Practical account and summary of the rearing of Tilapia in Katanga. 1. Construction, upkeep and management of ponds, with photographs. 2. Rearing methods. 2. Description of different species of Tilapia, with photographs.

(16) Bont, A.-F. de, and Hers, M.J. Croissance et dimorphisme sexuel chez les
1950 *Tilapia melanopleura* (DUM) et *T. macrochir* (BLGR.) en étangs. *Comptes rendus de la Conference piscicole anglo-belge, Elizabethville (Congo belge) 13-18 juin 1949.* Directions de l'agriculture du Ministère des Colonies et du Gouvernement Général du Congo Belge, Brussels, Belgium. pp. 313-320, figs., illus.

After establishing the growth curves for *T. macrochir* and *T. melanopleura* reared in ponds, expressing these as length and weight against age, the authors established that the males of these 2 species are bigger and more numerous than the females. Both species reach 150 g. in 10 months.

(17) Bont, A.-F. de, and Hulot, A. La carpe est-elle un poisson de culture pour le
1950 Congo ? *Ibid.*, pp. 279-283, illus.

Carp is dangerous for Tilapia because it digs into the bottom and destroys the eggs. Moreover, it disturbs the waters and reduces the production of plants eaten by Tilapia. Finally, Tilapia gives much higher yields than carp. Following a new order carp cannot be introduced into the Belgian Congo.

(18) Boulenger, G.A. Catalogue of the Freshwater Fishes of Africa in the British
1909- Museum. 4 vols. British Museum, Department of Zoology, London.
1916

The catalogue carries a list of 94 species of the genus Tilapia, with distinctive characteristics and illustrated with drawings.

(19) Cardozo, J.G.A. Sketch of Mozambique Inland Fisheries. *Record of the Sympo-*
1952 *sium on African Hydrobiology and Inland Fisheries held October*, 1952, *at Entebbe, Uganda.* Secretary-General, C.S.A., P.O. Box 5175, Bukavu, Belgian Congo. pp. 50-51. Price : 5s. or B.Frs. 35.

Mozambique, whose coastal border extends for nearly 3,000 km., draws its fish supply from the sea. Its inland fisheries are little developed although the inland waters are numerous and rich and contain in their natural state 4 species of Tilapia cultivated in the world : *T. mossambica, T. melanopleura, T. macrochir* and *T. sparmanni.*

(20) Charpy, B. La pisciculture en Afrique équatoriale française. *Ibid.*, pp. 39-43.
1952

The Service des Eaux et Forêts is responsible for the implementation of a program of development of fish culture in French Equatorial Africa. The Service has as base a central fish culture station at Djoumouna, near Brazzaville, for research, fry production, and the development of fish cultural techniques. Experiments, since 1951, have been on the 2 species already well studied in the Belgian Congo : *T. macrochir* and *T. melanopleura* which develop well ; growth curves, and artificial feeding with local industrial wastes have also been studied.

(21) Chen, Tung-Pai. The Culture of Tilapia in Rice Paddies in Taiwan. *Fisheries*
1953 *Series* No. 2. Chinese-American Joint Commission on Rural Reconstruction, Taipei, Taiwan (Formosa). 29 pp., figs., illus., bibl., tables.

Complete and precise account of the cultivation of *T. mossambica* in a temperate country. The species was introduced in 1944 and its use was encouraged by the Government. The climate is an important obstacle. Spawning and growth are limited to 7 months, during which the mean temperature is between 20° to 35° C. Tilapia are killed by a transient cooling to 10° C. or by a sustained temperature of 14° C. In S. Taiwan there are 6 to 11 spawnings each year, one every 22 days *T. mossambica* tolerates salt water to a density of 1.02 to 1.03. Cultivation in S. Taiwan is solely in rice fields. The stocking rates and programs are described.

Cultivation of Tilapia in rice fields is undergoing wide, but careful, extension. The Fisheries Service distributes fry and, for the spawners, constructs 4 ft. deep wintering ponds protected from cold winds and supplied with water from a warm spring. Tilapia production is still small.

(22) Copley, H. Some Random Notes on Pond Fish Culture in Kenya. *Record*
1952 *of Symposium on African Hydrobiology and Inland Fisheries held October, 1952, at Entebbe, Uganda.* Secretary-General, C.S.A., P.O. Box 5175, Bekavu, Belgian Congo. pp. 90-91.

The rearing of *T. nigra* and *T. melanopleura* in ponds began in Kenya in 1924. This cultivation is only poorly extended and it is not certain that Tilapia would be the best species of fish to cultivate in Kenya.

(23) Deceuninck, V. *La pêche et la pisciculture au Bas-Congo.* La Direction de
1952 l'agriculture des forêts et de l'élevage, 7 Place Royale, Brussels, Belgium. 64 pp., illus., fig., bibl. F.fr. 40.

Certain sections of the great river courses are favorable for fishing and 2 zones out of 6 are suitable for the construction of fish culture ponds. Fishing results are good at Stanley Pool. The Europeans have good results with the cultivation of Tilapia, and local inhabitants are getting better results. The project includes the creation of a principal fry center and one for applied research; and, for the local inhabitants, the provision of a pond for fry production, propaganda, and subsequently the construction first of collective ponds and then of individual ponds.

(24) Devadas, D.D. Peter, and Chacko, P.I. Introduction of the Exotic Cichlid
1953 Fish, *Tilapia mossambica* Peters, in Madras. *Curr. Sci., 22*: 29.

Five hundred fry of *T. mossambica* were imported to Madras from Ceylon on 8 September 1952; this was the first introduction into India of this fish.

(25) Didier, H. La pêche, sérieux appoint dans l'alimentation de l'Afrique noire.
1954 *Nouvelle revue française d'outre-mer,* 41 rue de la Bienfaisance, Paris 8. *46* (5): 198-206.

Fishing in open inland waters produces 60,000 tons in French West Africa and 30,000 tons in French Equatorial Africa and the Cameroons. These quantities are insufficient. Following the methods in the Belgian Congo, Tilapia ponds are being constructed in F.W.A. and are well advanced in F.E.A. and the Cameroons; 3,600 small family ponds for Tilapia were constructed in the Cameroons between 1950 and 1953.

(26) East African Fisheries Research Organization. *Annual Report* 1953.
1954 East Africa High Commission, Jinja, Uganda, 44 pp., tables.

This Organization includes several Tilapia specialists and has collected numerous data permitting the better understanding of water movements and their action on plankton and its density. Soils and waters of some African lakes lack sulphates. The algae (above all, diatoms) must construct themselves with amino acids containing the least possible proportion of sulphur. The planktonophagous Tilapia are more sensitive to the quality than to the quantity of algae, particularly diatoms, which is shown by a comparison of the growth of Tilapia of Lake George with the less favored Tilapia of Lake Victoria.

The fertility of a tropical lake is a function of the quantity of herbivores (fish, and mammals such as hippopotamus) living in it. Overfishing is serious because, in addition to the reduction of the stock of fish, it reduces fertility and leads to a situation which is serious for the future of certain lakes.

The introduction of nylon nets will conceal the deficit for a few years but it is expected that there will be a reduction in yield because the marking of Tilapia has shown that it requires 4 years for it to reach the minimum size of spawning. *T. zilii* (herbivore) gives excellent results in Uganda, with a high rate of growth, due to the fact that it nourishes itself with plants deeply rooted in the mud, and which contain highly nutrient materials out of reach of the plankton. It would be useful to introduce to the Lake *T. zillii* whose spawning and feeding habits differ from those of *T. esculenta* and *T. variabilis.* The sexual maturity of Tilapia was accelerated by exposure to full light.

The papyrus swamps are bad for the fish (little oxygen, high carbon dioxide); water lily swamps are better as the Tilapia can spawn there. The shade cast by the water lilies is unfavorable to plankton production and it would be useful either to remove the water lily and papyrus from the swamps or to drain the swamps and convert them into gardens where the richness of African soils, washed out by erosion, is collected.

(27) Eaux et Forêts. Pêche et pisciculture. *Rapport annuel de la section de re-*
1954 *cherches forestières pour 1953.* Yaoundé, Cameroons. F.W.A. Mimeo.

The central fish culture station of Yaoundé made experiments on the cultivation of *T. melanopleura* and *T. macrochir* and 2 local species of Tilapia. The family, as well as collective ponds, grew in number and they now cover 155 ha. The yields are still low because the initial stocking was low through lack of fry. *T. macrochir* seems at present to be of greater value for cultivation than *T. melanopleura.*

(28) Eaux et Forêts. *Pisciculture des Tilapia.* Station de pisciculture de la
1954 Djoumouna, Brazzaville, French East Africa.

This pamphlet, prepared by the Djoumouna Fish Culture Station at Brazzaville, describes a technique for the cultivation of Tilapia (*T. melanopleura* and *T. macrochir*) derived but differing from that of the Belgians, and applicable to the 1,200 Tilapia ponds recently created in F. E. Africa. *T. melanopleura* is adult at 7 months (12 cm.), *T. macrochir* at 8 months (14 cm.) with 8 spawnings in the year every 6 to 7 weeks. The growth of the male is 1.4 times that of the female and reaches 100 g. in 1 year. Artificial feeding is described.

Collective Exploitation. Optimum area of the ponds 20 to 50 ares, with 13 ponds (one is empty) emptied at the rate of 1 every 15 days, and 4 stocking basins of 5 ares. This gives daily production of 20 to 50 kg. *Family Exploitation.* Two ponds of 1 are, stocked with 25 adults and 300 fry, and 1 small stocking basin with intermediate fishing and a total fishing every 6 months.

(29) El Saby, Mohamed Kamel. The Lake Fisheries of Egypt. *Proceedings of*
1951 *the United Nations Scientific Conference on the Conservation and Utilization of Resources*, 1949. United Nations, Department of Economic Affairs, New York. *7* : 126-130. Price of volume, U.S. $ 2.50.

The brackish water lakes of the Nile Delta have an area of 550,000 acres and produce 26,000 tons of fish p.a. or 50 % of the total fish production of Egypt. The other lakes and the inland fisheries constitute 20 %. *T. nilotica, T. zilii* and *T. galilaea* make up 60 to 80 % of the total lake catch.

(30) Fish, G.R. Food of Tilapia in East Africa. *Record of Symposium on African*
1952 *Hydrobiology and Inland Fisheries held October, 1952, at Entebbe, Uganda.* Secretary-General, C.S.A., P.O. Box 5175, Bukavu, Belgian Congo. pp. 72-76.

Tilapia is herbivorous but each species has its vegetable preferences. Studies should be made of the digestion of Tilapia. *T. esculenta* and *T. variabilis* (Lake Victoria) and *T. nilotica*, which are planktonophagous, feed almost exclusively on diatoms, very little on other phytoplankton and practically not at all on crustacea. *T. zilii* and *T. melanopleura* eat the leaves and stems of aquatic plants. If, in cultivation, artificial vegetable foods are acceptable to the Tilapia, in open waters diatoms are the principal food.

(31) Gopinath, K. Fresh-water Fish-farming in the Malay Archipelago. *J. Zool.*
1950 *Soc. India, 2* (1-2) : 102-108.

Having described the cultivation methods in Malaya, the author reports on the introduction of *T. mossambica* at the Tapak experimental station.

(32) Food and Agriculture Organization of the United Nations. FAO *Fish-*
1954 *eries Bulletin*, Rome, Italy. VII (1), 36.

The FAO mission of Shimon Tal in Haiti has proved successful in the introduction of carp and Tilapia into the country and in rearing them by means of pond culture and rough release.

(33) Gouvernement Général du Congo Belge. *Notions d'élevage du poisson (Pi-*
1953 *sciculture des Tilapia).* Enseignements agricole, Leopoldsville, Belgian Congo. 31 pp., figs., illus., tables.

Practical and very simple account for extension officers teaching local people the cultivation of Tilapia for family consumption. Gives notes on the construction of a family pond, the feeding of Tilapia and its harvest.

(34) Graham M. *The Victoria Nyanza and its Fisheries. A Report on the Fishing*
1929 *Survey of Lake Victoria, 1927-1928.* Crown Agents for the Colonies, London. 256 pp., App.

By far the most important fish is *T. esculenta* which is of excellent quality. It seeks the shallow waters of the Lake (less than 20 m.) and zones around the rivers, particularly the papyrus areas, and feeds on phytoplankton and algae. The stock has diminished since the use of nets with 5 in. mesh (2 ½ in. between knots), but this reduction is not disturbing since the net catches only spawned fish. Where fishing is insufficient the Tilapia are too old and have too many large bones. Accurate statistics are needed to study the yield ; nets of less than a 5 in. mesh should be prohibited, and measures taken to prevent spoilage of nets. Maps give the distribution of Tilapia in the Lake and show this to be a function of food supply. Sexual maturity takes place at 26 to 27 cm. There is spawning throughout the year, with 3 spawnings per individual per year. *T. variabilis* is also found, and other species of fish.

(35) HALAIN, C. F. Réalisations de la Mission piscicole au Congo belge. *Comptes*
1950 *rendus de la Conférence piscicole anglo-belge, Elizabethville (Congo belge), 13-18 juin 1949.* Directions de l'agriculture du Ministère des Colonies et du Gouvernement Général du Congo belge, Brussels, Belgium. pp. 337-342, illus.

Fishing in the open waters of only 4 areas of the Belgian Congo (Luapula-Moero, Lualaba, Lakes Albert and Edward) yields 18,000 tons of consumable products each year : this produce must be protected and rationally exploited. Fish culture, which has given excellent results with *T. macrochir* and *T. melanopleura*, should be practised. The fish problem is only one of local policy. The fish culture mission created fry stations and organized practical courses to train extension officers.

(36) ————. Vidange d'un étang de la Cotonco à Sentery Territoire de Tshofa
1952 (Lomami). *Bull., agric., Congo belge, 43* (2) : 539-544.

A 6 ha. pond was stocked with 207 kg. of *T. macrochir* and *T. melanopleura* fry, and fertilized with cotton seed ; in 15 months it yielded 11 ½ tons of fish.

(37) ————. Bilan des réalisations piscicoles au Congo belge et Ruanda - Urundi.
1954 *Record of Symposium on African Hydrobiology and Inland Fisheries held October, 1952, at Entebbe, Uganda.* Secretary-General, C.S.A., P.O. Box 5175, Bakuvu, Belgian Congo. pp. 18-35, tables.

Fishing in open waters provides 38,500 tons per year, which should be increased. A fish culture service has been in operation since 1949. Cultivation of *T. melanopleura* and *T. macrochir* has been successful, and fry and spawners of these 2 species have been distributed in the Rhodesias, Madagascar, Sudan and F.E.A. Twelve fry stations for Tilapia have been constructed or are in course of construction.

(38) HEY, D. *The Culture of Freshwater Fish in South Africa.* Director of Inland
1944 Fisheries, P. O. Box 152, Stellenbosch, Union of S. Africa. Price : 2s. 6d.

Three species of Tilapia : *T. mossambica, T. melanopleura* and *T. sparmanni*, have been identified in S. Africa, the most common being *T. mossambica*. Distinctive characteristics and ecology of the 3 species have been studied, but more especially *T. sparmanni*, which is used as a forage fish at the Jonkershoek fry station. This station has also received specimens of *T. kafuensis* and *T. macrochir*.

(39) ————. *Fish Keeping in Ponds and Aquaria.* Director of Inland Fisheries,
1945 P.O. Box 152, Stellenbosch, Union of S. Africa, 62 pp., figs., bibl. Price : 1s. 6d.

T. sparmanni is briefly cited as an indigenous ornamental fish. It is vegetarian but eats various artificial foods.

(40) HEYDEN, W. F. L. van der. The Production of Fresh-water Fish and the Duties
1947 of the Extension Service in the Indies. *Paper* No. 14, Fisheries Conference, Singapore, January 1947. Office of Special Commissioner in South-east Asia, Singapore, 11 pp., mimeo.

Before 1939 Java and Madura produced 120,000 tons of fish of which 30,000 came from inland waters ; 100,000 tons were imported. Local production should be increased owing to growth of population. Reference is made to Tilapia, discovered in 1939 inhabiting brackish as well as fresh waters. It gave some production but of low economic value. The author identifies this Tilapia as *T. zilii* (subsequently found to be *T. mossambica*).

41) HICKLING, C. F. Tilapia Culture in Singapore. *Comptes rendus de la Confé-*
1950 *rence piscicole anglo-belge, Elizabethville (Congo belge)* 13-18 *juin* 1949. Directions de l'agriculture du Ministère des Colonies et du Gouvernement Général du Congo Belge, Brussels, Belgium. pp. 287-292, illus., figs.

T. mossambica imported to Singapore from Java by the Japanese in 1943 was cultivated by the Chinese in fresh water and in brackish water up to 20‰ salinity.

(42) HOFSTEDE, A. E. Statement from the Netherlands on the Fisheries in Indonesia.
1948 *Proceedings of the Indo-Pacific Fisheries Council* (Sub-Area Committee Meeting, Buitenzorg, Java) Maliwan Mansion, Phra Atit Rd., Bangkok, Thailand.

Brackish-water ponds. In the under-exploited ponds of Java (85,000 ha.) and of the Celebes (20,000 ha.), *T. mossambica* is an excellent acquisition and must be added when the supply of Chanos fry is insufficient, as it gives better growth and easily produces fry. The best method of cultivation in brackish waters must be studied.

Fresh water. Tilapia tends to displace carp. Selection is necessary.
Rice fields. Tilapia constitutes an excellent catch crop. It is sufficient to reinforce the dykes and to concentrate a little more on the cultivation of the fish. The 3 methods of cultivation are described.

(43) HOFSTEDE, A.E. Pond Culture of Warm Water Fishes in Indonesia. *Proceed-*
1951 *ings of the United Nations Scientific Conference on the Conservation and Utilization of Resources*, 1949. United Nations, Department of Economic Affairs, New York. 7 : 136-138. Price of volume: U.S.$ 2.50.

Fish, especially from cultivation, is the principal source of protein in Indonesia and is often reared in ponds by peasants for family consumption. Chanos and, since World War II, *T. mossambica*, are raised in tambaks (ponds with sea or brackish water). *T. mossambica* was discovered by chance and has the advantage of reproducing in ponds so that the introduction of fry is unnecessary. In fresh water, fish culture is practised as successfully in small pools of only a few square meters in area for family consumption, as in ponds of 1 to 2 ha.
Fish culture is practised in rice fields during the 3 to 4 month period when rice is not cultivated, or together with the rice with certain precautions for protection of the rice, by reinforcement of dykes and deepening of the ditches. The 2 species mainly cultivated are carp and *T. mossambica*, which are spreading widely. In rice fields the yields are 200 kg. per ha. per year, and in ponds up to 800 kg.

(44) ————, and ARDINAWATA, R. O. Compiling Statistical Data on Fish Cul-
1950 ture in Irrigated Rice Fields in West Java. *Landbouw, Buitenz, 22* : 469-494.

When rice fields are used for fish culture 2 factors must be studied – the water supply and the effects on rice culture. *T. mossambica* and carp have become the principal species cultivated in rice fields. The harvested fish should be from 75 to 100 g.
Two methods of combined rice/fish culture are described. In one the fish are raised between the rice harvest and the second planting ; in the other cultivation takes place during the growing period of the rice. The following results are recorded : it is possible to produce 30 to 50 kg. fish per ha. with the second method during the 40 to 60 days separating the sowing of the rice from its flowering, which represents a theoretical yield of 300 kg. per ha. p.a. The rice harvest is increased about 7 %.

(45) HORA, S. L. Malaria Control and Fish Culture. *Sci. & Cult., 17* : 94-95.
1951

Brief note on the necessity to experiment with *T. mossambica* in Calcutta (this has just begun in E. Bengal). The Calcutta ponds give only 25 to 80 kg. per ha. p.a., and could give 500 kg. with *T. mossambica* which would also destroy the mosquitos.

(46) ————. Pond Culture of Warm Water Fishes. *Proceedings of the United Na-*
1951 *tions Scientific Conference on the Conservation and Utilization of Resources.* 1949. United Nations, Department of Economic Affairs, New York. 7 : 120-124, bibl. Price of volume: U.S.$ 2.50.

China, India and other Asian countries have fish culture in ponds and techniques are described. Pond culture in Asian countries is described, and the importance of the spread of Tilapia culture in Indonesia is emphasized.

(47) HUET, M. Principaux problèmes de limnologie théorique et appliquée posés
1947 par l'Etude piscicole des eaux douces. Le problème piscicole au Congo belge. *Lovania* No. 12,. Elizabethville, Belgian Congo.

The aim of the development of fish culture in the Belgian Congo is better nutrition for the local inhabitants. A program of studies is outlined concerning firstly open waters with a study of the biology of various species, improvement of their yield, fishing methods, and the control of fish and, secondly, pond culture. To this end, the Fish Culture Station at Elizabethville is studying 5 species of Tilapia, *T. macrochir, T. sparmanni, T. melanopleura, T. nigra,* and *T. nilotica.*

(48) ————. Mission piscicole au Katanga. *Bull. agric. Congo belge, 34* (4) : 911-
1948 934.

Protein food requirements of the local inhabitants of inter-tropical Africa are estimated at 350,000 tons, whereas production is only 65,000 tons. Experiments have related to various species of Tilapia, *T. melanopleura* (herbivorous) and *T. macrochir* (planktonophagous) have been retained.

Method of cultivation. A spawning pond (2 to 5 ares) is stocked with 2 to 5 pairs of spawners per are. Spawning takes place every month during the rainy season. The fry, in suitable numbers, are then placed in larger ponds. The 2 species make use of artificial food (flour wastes, grasses, leaves) and of artificial manure. Annual production of 1,900 kg. per ha. has been reported at Elizabethville. The Tilapia reach 20 cm. and 150 g. at 12 months.

(49) HUET, M. *Traité de pisciculture.* Éditions de la Vie rustique, Avenue Georges
1953 Henri 299, Brussels, Belgium. 371 pp., figs., bibl.

A section is devoted to the culture of Tilapia in the Belgian Congo. After describing the characteristics of 2 species of value for cultivation, *T. macrochir* and *T. melanopleura*, their reproduction, natural and artificial feeding and their growth, the author gives 3 detailed methods of cultivation in small, shallow ponds (12 m^2 to 6 ha. in area : 0.5 m. to 2 m. deep) : 1. method derived from the Dubisch system with first and second holding ponds and a growing pond ; 2. method with only one pond in which spawners alone are placed ; 3. mixed method with a single pond, heavily stocked with fish of all sizes. A mixture of 2 species, *T. macrochir* (planktonophagous) and *T. melanopleura* (phytophagous) is recommended. The author reports yields from this method of 5,000 to 9,000 kg. per ha., and 10 times less in the case of poor ponds without artifical food.

(50) HULOT, A. Le problème piscicole dans la région forestière. *Comptes rendus*
1950 *de la Conférence piscicole anglo-belge, Elizabethville (Congo belge) 13-18 juin 1949.* Directions de l'agriculture du Ministère des Colonies et du Gouvernement Général du Congo Belge, Brussels, Belgium. pp. 273-276, fig.

Tilapia exist in this region and the fish culture station of Yangambi is supplied with *T. melanopleura* fry from the river. The cultivation of this species has been studied with feeding chiefly in forest fruits and leaves. The fry and spawners can be fed with termites.

(51) ————. Réalisations de l'I.N.E.A.C. en pisciculture. *Ibid.*, p. 277-278.
1950

The fish culture station of Yangambi has studied the cultivation of *T. melanopleura* since 1947. Its phytophagous habit has been determined ; fry have been sent to the Congo and to the Cameroons. The fish culture stations in the lower Congo and Ubangi also study this species, chiefly for stocking small ponds.

(52) ————. La régime alimentaire des poissons du centre africain. Intérêt
1950 éventuel de ces poissons en vue d'une zootechnie économique au Congo belge. *Bull. agric. Congo belge, 41* (1) : 145-176.

Researches on the species most valuable for cultivation in the Belgian Congo. These species are phytophagous, grow to more than 200 g., have few bones and are hardy. Tables give details of numerous observations on stomach contents of various species of fish, including *T. melanopleura* (phytophagous, eating mainly cynodon) ; *T. macrochir* (planktonophagous) ; *T. nigra* (phytophagous) ; and *T. sparmanni* (too small and too prolific and therefore eliminated from fish culture except as a forage fish).

(53) ILAN CHAIM, and SARIG, SHMUEL. Fish Breeding in Ponds in the Far East.
1952 *Bamidgeh,* Ministry of Agriculture, Fisheries Department, Israel. *4* (5-6) : 62-84, illus., tables.

Describes ponds and rice fields in the Far East. The reproduction and growth of *T. mossambica* result in higher yields than from other fish. *T. mossambica* is sold at unit weight of 30 to 50 g. but reaches a greater size in brackish waters.

(54) IRVINE, F.R. *The Fishes and Fisheries of the Gold Coast.* Crown Agents for
1947 the Colonies London.

In the check list of sea, brackish-water and fresh-water fishes of the Gold Coast, the following species are listed and described : *T. zillii Guineensis, T. melanopleura, T. heudelotii, T. nilotica. T. galilaea, T. busumana, T. multifasciata* and *T. discolor.* The last 3 are endemic to the Gold Coast, and the last 2 to Lake Bosumtwe only. The best species for mosquito control is *T. heudelotii.* Fishing gear and methods of preparation are described ; there is no mention of fish culture.

(55) Job, T.J. Report of the Sub-Committee on Fish Culture. *Proceedings of the* 1952 *Indo-Pacific Fisheries Council* (4th Meeting, Quezon City, 1952), Maliwan Mansion, Phra Atit Rd., Bangkok, Thailand, *1* : 70-72.

The yield of tropical and sub-tropical fish culture waters is high. Information on the culture of *T. melanopleura* has been collected from various research stations. Thailand has sent *T. mossambica* to Israel, India and Pakistan, and Singapore has sent this species to Borneo.

(56) ———. International Fish Seed Exchange. (Fish Seed Distribution in the 1953 Indo-Pacific Area). *Ibid.*, *2* : 208-209.

The article describes the conservation and distribution of fry in the Indo-Pacific area. Among the species for which numerous governments make demands for fry, *T. mossambica* is especially mentioned.

(57) Kantor Perikanan Darat. *Pedoman Perikanan Air Tawar.* Djakarta, In-1951 donesia. 36 pp., illus. English summary.

A practical guide to the culture and capture of fresh-water fish, of which there is great need in Indonesia for nutrition. Apart from fish culture in brackish waters, a part of the catch is supplied by fishing in open waters which must be protected and controlled. There are ponds for family production and others for market production. Rice fields could be used either during the period of 1 to 3 months when the rice is not uncultivated, or during the cultivation of the rice. The dykes must be reinforced. The species cultivated are : *T. mossambica* (Mudjair) herbivorous, *Cyprinus carpio, Puntius javanicus, Osphronemus goramy, Trichogaster pectoralis, Helostoma temmincki,* and *Osteochilus hasselti.* Fertilization and natural nutrition are manure, oil cakes, leaves, and rice wastes. The enemies of the fish are mainly otters and birds, then water snakes and crabs and lastly, floods. Tilapia destroy mosquitos.

(58) Kelsall. J.D. Breeding of *Tilapia esculenta* in the Tanganyika Waters of Lake 1954 Victoria. *Record of Symposium on African Hydrobiology and Inland Fisheries held October, 1952, at Entebbe, Uganda.* Secretary-General, C.S.A., P.O. Box 5175, Bakavu, Belgian Congo. pp. 70-71.

Observations on the spawning of *T. esculenta,* which is accompanied by migrations and is stimulated during the rainy season.

(59) Le Mare, D.W. Fish Culture – *Tilapia mossambica* (Peters). *Federation of* 1950 *Malaya and Singapore, Fisheries Department Annual Report.* 1949. Government Publications Bureau, G.P.O., Fullerton Bldg., Singapore. pp. 130-139. Price of Report : Straits $2.00

A first experiment in cultivating *T. mossambica* in rice fields in 1949 gave promising results. This species conforms to the particular conditions of rice culture since it develops quickly and reproduces young constantly while still young. *T. mossambica* is excellent for malaria control, and it is being tested at Penang for the control of filariasis, of which the vector is the mosquito. The fry station at Tapak is supplied with the fry of *T. mossambica.* Some results have already been given on the cultivation of this species, but there must be further research. The stocking rates and programs are described. Annual yields are 1,065 lb. per acre with feeding, 800 lb. per acre with manure.

(60) ———. The Pond Cultivation of Fish in the Colony of Singapore. *Ibid.*, 1950 pp. 130-139.

Introduced from Java by the Japanese in 1944 because of the cessation of importations of carp fry, *T. mossambica* has been cultivated in fresh-water ponds but, after preliminary success, its cultivation has declined greatly in favor of carp. *T. mossambica* is well acclimatized to open waters, both fresh and brackish. However, experiments made since 1947 in salt-water ponds have given excellent yields of Tilapia of good size and exceeding 1,200 lb. per acre if these ponds are near Malayan dwellings and cattle yards which furnish natural enrichment. *T. mossambica* will prove useful in mangrove, brackish-water ponds, which do not lend themselves to the cultivation of shrimps.

(61) Lemasson, J. Rôle des eaux continentales dans l'augmentation des ressources 1951 alimentaires de l'Afrique noire. *Bois For. Trop.*, (20), 259-263, illus.

Only fishing and fish culture can supply the 200,000 tons of animal products which are lacking in the nutrition of 24 million inhabitants of F.E.A. Fish culture, stimulated by the success of culture of Tilapia in the Belgian Congo, should supply an important part of this tonnage in future.

(62) LEMASSON, J. La Station de pisciculture de la Djoumouna. *Ibid.* (33).
1954

This station, near Brazzaville, in the Middle Congo, has more than 50 experimental ponds in which the culture of *T. melanopleura* and *T. macrochir* are being studied and where, since 1933, African fish culture extension workers have been trained.

(63) ————. L'exploitation des eaux continentales de l'Afrique française inter-
1954 tropicale. *Bull. franc. Piscic., 26* (173) : 143-149.

French inter-tropical Africa needs 500,000 tons of animal products of which only a part is produced ; of this 110,000 tons are reached by fishing fresh-water fish. Tilapia is present in the coastal salt lagoons. A Fisheries Service has just been established. Culture of Tilapia began in 1950 in F.E.A. and in the Cameroons at fish culture stations where 2 local species, *T. nilotica* and *T. galilaea* have been studied. 600 small ponds have been built in the neighborhood of Brazzaville, and 2,000 in the Cameroons, for family culture.

(64) ————. Note sur les problèmes piscicoles de l'Afrique occidentale française.
1954 *Record of Symposium on African Hydrobiology and Inland Fisheries held October, 1952, at Entebbe, Uganda.* Secretary-General, C.S.A., P.O. Box 5175, Bakavu, Belgian Congo. pp. 36-38.

Fishing in the inland waters of F.W.A. yields 50,000 tons of fresh fish per year. It is concentrated almost entirely in the central delta of the Niger where 20,000 km² of land are regularly flooded, in Senegal and in the lakes and lagoons of Bas-Dahomey. The introduction of fish culture, especially in brackish waters, is contemplated. The Central Experimental Station at Bamako is studying *T. nilotica, T. galilaea* and *T. melanopleura* for fish culture.

(65) LE TOUZEY, R. Les possibilités de la pisciculture pour l'alimentation des
1952 populations africains. *Bois For. Trop.*, (22) : 113-8.

Only fish culture can meet the high protein needs of the population of F.E.A. *T. melanopleura, T. nigra* and *T. macrochir* have been introduced from the Belgian Congo and the Cameroons by the Central Fish Culture Service at Yaoundé : numerous ponds are being constructed ; they are fished by net and then completely emptied.

(66) LIN, S.Y. Fish Culture Projects in Haiti and the Dominican Republic. *FAO*
1953 *Fisheries Bulletin*, FAO, Rome, Italy. *6* (6) : 230-234, illus.

Haiti. An FAO mission (S.Y. Lin and Shimon Tal) in 1952 established a five-year plan for development of inland fisheries, having already introduced carp from the U.S.A., and *T. mossambica* from Jamaica. Since 1951 the spawners of the 2 species have given numerous fry. Popularization has been very successful, Tilapia is highly appreciated, numerous culture ponds have been built and the number increases. Since 1953 in certain open waters Tilapia represents 90 % of the catch. Cultivation in rice fields has not yet begun.

Dominican Republic. In 1953, the FAO Mission (S.Y. Lin) prepared a fish culture plan similar to that for Haiti. The first culture center has been built and has already produced carp and Tilapia fry.

(67) LING, S.W. Inland Fisheries Project in Thailand. *Ibid.*, pp. 223-230, illus.
1953

Cultivation of carp has been practised in Thailand by Chinese immigrants for some 40 years. In 1951, an FAO mission (S.W.Ling) formulated a fish culture project. *T. mossambica* was introduced and is already found in 10,000 private ponds. A typical Tilapia pond is described.

Popularization, strongly supported by the Government, has been very successful and a technical fisheries service to distribute fry has been created. Tilapia has been established in swamps but not in open waters because of predators. Fish culture in rice fields is developing. A technical and extension service is in operation.

(68) ————, and SIDHTHIMUNKA, ARIYA. *Culture Tilapia — for Food and Profit.*
1953 Bangkok, Thailand. 7 pp. Mimeo.

Describes a program carried out by the Government of Thailand with the cooperation of FAO. After listing the advantages of culturing *T. mossambica*, a chapter deals with culture in ponds. The addition of artificial food (rice wastes, coconut flour, nut oil wastes) is recommended, also the cultivation of Ipomoea at the edge of the pond. Another chapter deals with the cultivation of Tilapia in rice fields and describes the management of ditches. Government fish culture stations provide fry. The production ponds can be family or commercial.

(69) LOCKLEY, G.J. The Development and Investigations of the Inland Fisheries
1950 of Tanganyika Territory. *Comptes rendus de la Conférence piscicole anglo-belge, Elizabethville (Congo belge) 13-18 juin 1949.* Directions de l'agriculture du Ministère des Colonies et du Gouvernement Général du Congo Belge, Brussels, Belgium. pp. 135-138.

One fisheries officer is responsible for the fisheries of Lake Tanganyika and Rukwa, another, for fish culture, to encourage the creation of fish culture establishments and to experiment with local species of Tilapia. Two experimental stations for the culture of Tilapia have been established at Korogwe and Morogoro.

(70) LOWE, ROSEMARY H. Report on the Tilapia and other Fish and Fisheries of
1952 Lake Nyasa 1945-47. Colonial Office, *Fishery Publication 1* (2) : 1952. H.M. Stationery Office, York House, Kingsway, London W.C. 2. 126 pp., figs., tables. Price : £2.0.0d.

Gives the precise systematics of the 6 Tilapia species in Lake Nyasa, namely, *T. squamipinnis, T. saka, T. lidole, T. karongae, T. shirana* and *T. melanopleura.* Growth has been studied by opercular bones. Buccal incubation takes place in all the species except *T. melanopleura* and all are phytophagous. The lowering of the level of the lake leads to variation in the stock of each species. The different fishing gears are described. 3,000 tons of Tilapia are taken each year and the presence of this species is vital for the economy of the lake. Stocks, except *T. lidole*, are low. To protect immature fish, a minimum size for catching should be set, spawning protected, and the quantity taken each year controlled.

(71) ————. Some Aspects of Tilapia Research in East Africa. *Record of Sym-*
1954 *posium on African Hydrobiology and Inland Fisheries held October, 1952, at Entebbe, Uganda.* Secretary-General, C.S.A., P.O. Box 5175, Bakavu, Belgian Congo. pp. 68-69.

Research on Tilapia must relate to both open and closed waters. At present *T. esculenta, T. variabilis* and *T. nilotica* are being studied. New species of Tilapia have recently been found. In the lakes Tilapia have different habitats for spawning, for raising their young and for feeding. 70 % of the adults carry spawning marks on their scales. Observations have been made on spawning and on growth, which is less in ponds than in lakes.

(72) MAAR, A. The Background for, and the Development of, Fisheries in Southern
1954 Rhodesia. *Ibid.*, pp. 52-55.

In its nutrition policy, S. Rhodesia must also recognize the growing need for protein foods. The fish of inland waters must meet these needs because the natural waters are abundant with them and already there are 5,000 ponds and artificial reservoirs with a total area of 12,500 ha. Experiments will begin with 3 endemic species : *T. mossambica, T. melanopleura,* and *T. macrochir,* which have already been proved elsewhere. Experimental fish culture was initiated in 1951, at the Henderson Research Station, near Salisbury.

(73) MOURANCHE, R. Le développement de la pisciculture à Madagascar au cours
1954 de ces dernières années. *Ibid.*, pp. 45-49.

T. nigra was imported from Kenya in 1950 to a pond which was too cold in winter ; it must now be tried at a lower altitude. *T. macrochir* and *T. melanopleura* were imported from Brazzaville in 1951 and seem to give better results than *T. nigra.*

(74) NAZIR, AHMAD. Fish Culture in Pakistan. *Proceedings of the Indo-Pacific Fish-*
1952 *eries Council* (3rd Meeting, Madras, India, 1951), Maliwan Mansion, Phra Atit Rd., Bangkok, Thailand. *2*:170-172.

Review of fish culture methods in the fresh and brackish waters of Pakistan. 500 *T. mossambica* Peters were recently imported from Singapore for trial in the brackish waters of the Punjab.

(75) PANIKKAR, N.K., and TAMPI, P.R.S. On the Mouth-breeding Cichlid, *Tilapia*
1954 *mossambica* Peters. *Indian Journal of Fisheries,* Government of India Central Marine Fisheries Research Station, Mandapam Camp P.O., S.I. Rly., S. India. *1* (1-2) : 217-219. Price : 7 Rs. 8 As.

The authors review, generally, current knowledge and recent observations on Tilapia, notably, *T. mossambica.*

(76) PITMAN, C.R.S. Organization and Development of Uganda's Fisheries. *Comptes*
1950 *rendus de la Conférence piscicole anglo-belge, Elizabethville (Congo belge), 13-18 juin 1949.* Directions de l'agriculture du Ministère des Colonies et du Gouvernement Général du Congo Belge, Brussels, Belgium. pp. 125-130.

Fish culture is essential for the development of East Africa. Research relates particularly to the magnitude of spawning of the various species of Tilapia. Crocodiles and pelicans, serious predators of adult Tilapia (*T. nilotica*) should be destroyed. A pelican eats 1 ton of consumable fish each year. Gill nets used in Lake Victoria make the fishing destructive to Tilapia.

(77) SAMSON, A.D. The Fisheries of Nyasaland. *Ibid.*, pp. 139-142, illus.
1950

A third of Nyasaland is under water. Since 1942, studies have been carried out on the endemic species of Tilapia : *T. squamipinnis* and *T. lidole*. Tilapia fisheries are the most important, but variations in the level of the lake cause fluctuations in the relative importance of the stocks of the different species. Experiments have been made at cultivating Tilapia in pools on the edge of the lake.

(78) SCHUSTER, W.H. Fish Culture as a Means of Controlling Aquatic Weeds in
1952 Inland Waters. *FAO Fisheries Bulletin*, FAO, Rome, Italy. *5* (1) : 15-24. bibl.

In Europe and the U.S.A., excessive aquatic vegetation reduces fish yield. This is controlled by weed removal, or by the use of copper sulphate, of 2,4-D or of benoclors, but this is expensive. The problem is even greater in tropical waters where the vegetation grows throughout the year. But happily there are phytophagous fish ; milk fish, Ctenopharyngodon and Tilapia (especially *T. melanopleura*) which constitute the best solution. Other phytophagous local species of fish should be sought, for the problem is not yet completely solved, especially in respect of Eichhornia which is resistent to fish known at present and which in Indonesia must be combated with 2,4-D.

(79) ————. Fish Culture in Brackish-water Ponds of Java. Indo-Pacific Fish-
1952 eries Council, *Special Publications* No. 1, Maliwan Mansion, Phra Atit Rd., Bangkok, Thailand. 143 pp., illus., tables, bibl.

Deals primarily with the cultivation of Chanos and shrimps and subsidiarily with *T. mossambica*, for which great cultivation possibilities in brackish water are underlined. The author describes how, at the end of 1939 with Mudjair, he discovered, by chance, 5 specimens of *T. mossambica* at the village of Papungan, E. Java ; 2 of these were incubating females. The Tilapia then spread naturally and artificially to the fresh and brackish waters of Java, primarily because of the lack of Chanos fry during the war. In brackish water Tilapia gives high yields without harm to Chanos, but is injurious to the shrimps for which there is a higher price on the Singapore market.

(80) ————. A Provisional Survey of the Introduction and Transplantation of
1952 Fish throughout the Indo-Pacific Region. *Proceedings of the Indo-Pacific Fisheries Council* (3rd Meeting, Madras 1951), Maliwan Mansion, Phra Atit Rd., Bangkok, Thailand. pp. 187-196.

Report on the distribution by man of various species of fish in the Indo-Pacific region. A table gives the dates of recent systematic distribution of 18 species, including *T. mossambica*, by 48 planned transplantations.

T. mossambica already produces 5,000 tons in Java alone. The ecological requirements of 20 species are given. *T. mossambica* is an omnivore eating Chlorophyceae, Cyanophyceae, Conjugatae, Characeae, Diatomeae, Crustacea, and detritus. It can be cultivated in tropical waters up to 1,000 m. above sea level. Having low requirements of oxygen and living space it spawns in captivity, and produces 500 kg. per ha. per year. It can be cultivated in both closed and open waters, and is especially important for stocking swamps or marshes which dry up annually. It adapts itself to brackish waters and is good to eat. *T. mossambica* is spreading throughout the region by itself and by the efforts of man. It would be useful to study its culture possibilities under various local conditions before its spontaneous arrival.

(81) ————. *Report on the Possibilities for Fish Culture in East Pakistan.* FAO,
1952 Rome, Italy. 22 pp., bibl. Mimeo, free.

The area of the fresh and brackish waters of E. Pakistan in which fish culture is possible is 21,550,000 acres, of which 20,193,000 are under rice. The population, 90 % peasant, is undernourished. The fish used in rice fields are carp and *Trichogaster pectoralis*. It would be valuable to introduce *T. melanopleura* into water reservoirs, infested with mosquitoes, also to silted reservoirs and, after experimentation, to rice fields. FAO assistance is necessary.

(82) SHELUBSKY, M. A Review of Fish Farming in Israel. *Proceedings of the United Nations Scientific Conference on the Conservation and Utilization of Resources*, 1949. United Nations, Department of Economic Affairs, New York. 7 : 147-150, tables. Price of volume : U.S.$2.50.
1951

Fish culture is an important source of food in Israel because there are great areas of marsh and numerous brackish waters, useless for agriculture. Fish culture dates from 1938 and is expanding. In 1949, 2,000 ha. were under cultivation and produced 3,000 tons of fish, chiefly carp. Tilapia, which is indigenous, sometimes enters the pond spontaneously, and experiments are in progress to determine the Tilapia most valuable for cultivation.

(83) SKLOWER, A. Fish Farming and Fresh-water Biology in Northern Rhodesia. *Arch. Hydrobiol.* (*Plankt.*), *45* : 284-312.
1951

N. Rhodesia has a great need of fish for food, but local difficulties for promoting fish culture are numerous, chiefly because of scarcity of water and ponds. Precise instructions can now be given to farmers, among whom a notice concerning fish culture has been distributed. The work of fish culture stations dates from 1942.

In N. Rhodesia, there are 7 species of fish of which 4 are indigenous and 3 are Tilapia. *T. andersonii* (kafluensis) does not reproduce in small ponds. Only *T. melanopleura* and *T. macrochir* are of value for cultivation and can be raised together, or with tench. Scale reading is difficult because of spawning marks, and so is the reading of the otolith if the temperature is equable throughout the year. Yields are from 200 to 900 kg. per acre per year and can be quadrupled if artificial food (maize flour) and fertilizers (50 kg. of super-phosphate and 1 ton of manure per ha.) are used.

(84) SOMEREN, V.D. van. River Research in Kenya Colony. *Comptes rendus de la Conférence piscicole anglo-belge, Elizabethville* (*Congo belge*), *13-18 juin 1949*. Directions de l'agriculture du Ministère des Colonies et du Gouvernement Général du Congo Belge, Brussels, Belgium. pp. 71-77.
1950

T. nigra has been used for fish culture for 25 years, and combined cultivation of Tilapia with black bass has been attempted. The shores of Lake Victoria could be used for the cultivation of the species of Tilapia endemic to the Lake. An experimental fish culture farm using only Tilapia will be created. Introduction of carp will be prohibited.

(85) UNION OF SOUTH AFRICA. Inland Fisheries Department, *Report* No. 1. (1944). Superintendent of Inland Fisheries, Box 152, Stellenbosch. viii + 47 pp.
1945

Among the indigenous fishes mention is made of *T. mossambica*, found in the basins of the rivers flowing towards the Indian Ocean. A specimen weighing 1,700 g. is preserved in the Jokershoek Museum. The flesh is good, although inferior to that of bass. *T. sparmanni*, in which buccal incubation does not occur, is a smaller species whose maximum length is 22 cm. Attempts to introduce *T. nigra* from Nairobi took place in 1942 and 1943 but failed because winter temperatures are too low. Attempts are also being made with *T. kafuensis*.

(86) VAAS, K.F. Preliminary Report on Air Transport of Live Fish in Sealed Tins under Oxygen Pressure. *Proceedings of the Indo-Pacific Fisheries Council* (3rd Meeting, Madras 1951), Maliwan Mansion, Phra Atit Rd, Bangkok, Thailand. pp. 119-128, bibl. tables.
1952

The author describes his experiments in transporting small fish over great distances in jerry cans under oxygen pressure. He cites especially 4 experiments in the transport of *T. mossambica* for periods from 24 to 244 hours with 100 % success. A table and a graph concerning 6 to 7 cm. *T. mossambica* show that the product of journey time by total fish time is constant. However, during transport pH falls, calcium and CO_2 increase and CO_2 ends by killing the fish. Buffer solutions absorbing the CO_2 are used and, taking into consideration that small fish consume proportionately more oxygen than the big, the author finds the following equation for Tilapia : $NW^{2/3}T$ = a constant, within 3 % when N = number of fish, W = mean weight and T = travel time. This formula then allows calculation of the number of Tilapia safely transportable in a container for a given duration.

(87) ———, and HOFSTEDE, A.E. Studies on *Tilapia mossambica* Peters (ikan mudjair) in Indonesia. *Contributions of the Inland Fisheries Research Stations* No. 1, Djakarta-Bogor, Indonesia. 68 pp., figs., tables, bibl.
1952

T. mossambica was found by chance in Java in 1939 and has since been studied and propagated by fish culture. The Japanese propagated it during the war in 1942 because of the poor supply of fry for brackish waters. The simplest indigenous culti-

vation of Tilapia uses water holes into which manure and wastes are thrown. An interesting Javanese technique for procuring Tilapia fry, with separate spawning ponds and growing ponds, is described in detail. The morphology and biology of Tilapia have been studied. It is a phytophagous euryhaline (from 3 to 4 % salinity); spawning and buccal incubation by the female have been studied in detail. Although easily distinguishable during the reproduction period, the sexes cannot be differentiated other than by the genital apparatus (3 orifices in the female, 2 in the male) which is visible to the naked eye at a size of 6 to 7 cm. and, with a magnifying glass, at 3 to 5 cm.

In open waters Tilapia suffer great losses from predators. If there are few predators, it gives an important stock which is easy to capture for it lives in schools near the surface. In combined cultivation with carp, Tilapia restricts the growth of the carp without being harmed itself. If conditions are good for carp it is better not to add Tilapia. In Java, Tilapia is little used in rice fields because it gives a lower yield than carp, but its easy cultivation has made an excellent introduction into fish culture where carp is unknown.

(88) Vries, E. de, and Bottemanne, C.J. Latent Fishery Resources and Means
1951 for their Development. *Proceedings of the United Nations Scientific Conference on the Conservation and Utilization of Resources*, 1949. United Nations, Department of Economic Affairs, New York. *7*: 39-41. Price of volume: U.S. $2.50.

Discusses, among prospective food resources, cultivation of fresh-water fish. *T. mossambica*, whose numerous qualities may be considered beneficial for Indonesia where it gives 400 kg. per ha. in pools which otherwise are valueless, is especially mentioned.

(89) Wilbaux, R. Note sur *Tilapia nilotica* L. du sud du Lac Albert. *Bull. agric.*
1947 *Congo belge*, *38* (3): 619-626, illus., tables.

T. nilotica is abundant in Lake Albert and reaches a length of 49 cm. A table and a curve give the relations between the length and the weight of *T. nilotica*: another table shows the yield in drying and salting. A table is given for differentiation between 5 species of Tilapia, *T. macrochir*, *T. melanopleura*, *T. sparmanni*, *T. nigra* and *T. nilotica*.

(90) Worthington, E.B. *A Report on the Fisheries of Uganda*. Crown Agents for
1932 the Colonies, London.

1. *Lakes Edward and George and Kasinga Canal*. *T. nilotica* and, subsidiarily, *T. eduardiana*, are found in the lakes of which a physico-chemical study is given. *T. nilotica* is omnivorous and reaches a length of 46 cm. Buccal incubation takes place in the females, which are more numerous than the males. Tilapia has few parasites. It profits by the absence of crocodiles and predatory fish. It is fished chiefly with a 5 in. gill net (2 ½ in. between knots), and with conical traps leading and enclosing the fish in shallow pools. The latter system captures mainly the females, and gill nets should be promoted. If there is over-fishing spawning reserves could be established in the papyrus marshes. Salting should be encouraged.

2. *Lake Bungori*. No Tilapia. Introduction of *T. nilotica* has failed because the lake is at too great an altitude (6,500 ft.). *T. nigra* should be introduced.

3. *Lakes Nakavili, Kachira and Kyanebalola*. No Tilapia. *T. esculenta* and *T. variabilis* should be introduced from Lake Victoria.

4. *Lake Nabugubo*. *T. esculenta* is scarce because of over-fishing.

(91) ————. Biology of Speciation in African Lakes. *Record of Symposium on*
1954 *African Hydrobiology and Inland Fisheries held October, 1952, at Entebbe, Uganda*. Secretary General C.S.A., P.O. Box 5175, Bakavu, Belgian Congo. pp. 83-85.

Study on the speciation of various species of Tilapia in African lakes, and notably on the influence of food and predators.

(92) Zwilling, K.K. Panyam Fish Farm, Nigeria. *Ibid.*, pp. 88-89.
1954

Since 1950, ponds for raising *T. nilotica*, *T. galilaea* and *T. melanopleura* have been constructed on this Nigerian farm.

(93) Zylva, E.R.A. de. Fish Farming in Malaya (As a Guide to Fish Farming in
1952 Ceylon). *Bulletin* No. 4, Department of Fisheries, Colombo, Ceylon. 9 pp., illus., bibl.

Brochure with numerous photographs on the cultivation of fish in Malaya, to serve as a guide to fish culture in Ceylon, and dealing above all with carp. Chinese and Malayan methods must be adapted to local customs (especially the use of manure)

and annual importation of grass carp fry, which does not reproduce in ponds, is costly. The author refers to results with *T. mossambica* and recommends cultivation of this fish in the inland waters of Ceylon.

(94) ————. *Administration Report of the Acting Director of Fisheries for 1953.* 1954 *Part. IV - Education, Science and Art* (L.). Governments Publications Bureau, Colombo, Ceylon. 40 pp., tables, figs. Price: 1 Rs. 25 As.

T. mossambica, introduced into Ceylon in 1952, is distributed by the Fisheries Service in open and closed inland waters. Tilapia already constitutes 80 % of the catch from certain lakes ; it survived the dry seasons of 1952 and 1953 in reservoirs which almost completely dried up.

Note to Readers

In the foregoing article, and in future issues of the *FAO Fisheries Bulletin* wherethere are bibliographies, the standardized and abbrevi-s ated form of reference to scientific periodicals given is that used in the *World List of Scientific Periodicals*, published by Butterworth Scientific Publications, London.

Readers who may wish to consult these papers and who have access to scientific libraries, should have no difficulty in using these references. For those who have no such services, we give below a list of offices and libraries which may be approached for assistance :

FAO Headquarters, Rome, and Regional Offices (Bangkok, Thailand ; Geneva, Switzerland ; and Santiago, Chile).

Principal libraries and documentation centers :

France	Bibliothèque nationale, 58 rue de Richelieu, Paris, 2.
	Centre national de la recherche scientifique, Centre de Documentation, 18 rue Pierre Curie, Paris 5.
India	National Library of India, Belvedere, Belvedere Road, Calcutta, 27.
	Indian National Scientific Documentation Centre, c/o National Physical Laboratory of India, Hillside Road, New Delhi 12.
Italy	Centro Nazionale Informazioni Bibliografiche Via del Collegio Romano, Rome.
United Kingdom	British Museum, Great Russell Street, Bloomsbury, London, W.C.1.
	National Central Library, Malet Place, London, W.C.1.
U.S.A.	The Library of Congress, Washington 25, D.C.
	The John Crerar Library, 86 East Randolph Street. Chicago 1, Illinois.

OPERATION MERLUZA [1]

The second Five Year Plan (1952-57) of the Republic of Argentina foresees an increase in fish production of about 185% above the average for 1947-51 (67,000 tons), to reach a volume of 200,000 tons in 1957.

To obtain such an increase a co-ordinated research program [2] for the systematic investigation of the continental seas of Argentina, to be carried out at sea and in various scientific institutions of the country, was started in May 1954.

The program encompasses :

1. physical, chemical and biological studies of the sea ;
2. study of the geological characteristics of the sea bottom ;
3. study of the areas of major concentration of hake (merluza), a basic resource for the trawl fisheries ;
4. study of the populations of hake (merluza) covering age composition, growth, feeding habits, reproduction and migration ;
5. investigation of the correlation between the variations of productivity of the seas and the natural fluctuations in the annual yield of the commercial fisheries ;
6. calculation of exchanges between the sea and the atmosphere for future climatologic predictions based on oceanographic data.

The following institutions will be co-operating in this program : The Oceanography Branch of the Division of Navigation and Hydrography ; the recently created Fisheries Research Branch in the Fish and Wildlife Service (Dirección General de Pesca y Conservación de la Fauna) the National Institute for the Investigation of Natural Sciences " Bernardino Rivadavia ; " and the School of Sciences of the University of Buenos Aires. Scientists from other institutions will also take part.

The first expedition was conducted during May and June 1954 with the oceanographic vessel *Madryn*, of the Ministry of the Navy, in the main trawl fishing areas, between the latitudes 36°S. and 42°S. The chemists, general biologists and fishery biologists taking part in this investigation were divided into working groups of three members each, covering the study of plankton, benthos, physical oceanography, and commercial fisheries.

Observations and collections were made in 53 oceanographic stations from the surface to a depth of 500 meters. On board the vessel determinations of phosphates, alkalinity and pH were made. Water samples for determining salinity, oxygen and other elements were analyzed by the Oceanography Branch of the Ministry of the Navy,

[1] Material supplied by Dr. Zacharias Popovici of the National Institute of Investigation of Natural Science " Bernardino Rivadavia " and of the Ministry of the Navy.

[2] *See FAO Fisheries Bulletin*, VII (4), 188.

and samples of bottom sediments are being studied in the National Institute for the Investigation of Natural Sciences. Fish collections have been distributed to this Institute and the Fisheries Research Branch for examination.

Concurrently with this expedition, fishery biologists went out with the trawlers to make a general study of the species caught, with particular regard to the yield of hake per haul in the areas where oceanographic observations are being made.

The *Madryn* will make further oceanographic expeditions, one during each season of the year, to obtain a complete cycle of observations, and each month fishery biologists will go out in different types of fishing boats to make continuous observations, to collect samples of hake, pursue the study of the life cycle of this fish, and to determine the fishery potentialities of the Argentinian waters.

This research program, which is being initiated and developed in the Argentine, at present covers a limited number of related oceanographic and fisheries problems ; however, these are well defined and of immediate interest to the country. It also proves the advantage of co-operation between the institutions engaged in a combined effort which permits a maximum yield with a minimum of expense.

The final results of these investigations will be used as basic data for the composition of fishing charts, which will be edited by the Division of Navigation and Hydrography in co-operation with the Fish and Wildlife Service. They will also help to establish norms to be followed in the exploration of the fisheries resources of the country.

Conferences and Meetings

Calendar for 1955-1956

1955

January	2	Indian Science Congress- 42nd Session	Baroda
March	15	Economic Commission for Europe	Geneva
"	17	3rd Inter-American Statistical Conference	Santiago
"	28	Economic Commission for Asia and the Far East - 11th Session	Tokyo
"	29	Economic and Social Council - 19th Regular Session	New York
April	12	International Union of Biological Sciences - 12th General Assembly	Rome
"	14	2nd World Meteorological Conference	Geneva
"	18	UN International Technical Conference on the Conservation of the Living Resources of the Sea	Rome
April		International Conference on Marine Biological Laboratories	Rome
"		Latin American Fisheries Commission	
May	3	Permanent Commission of the International Fisheries Convention 1946 - 4th Meeting	London
"	16	Economic and Social Council - 19th Session (resumed)	New York
"		Economic Commission for Latin America	Bogotá
June	6	International Commission for the Northwest Atlantic Fisheries - 5th Annual Meeting	Ottawa
"	11	International Organization for Standardization - Council and General Assembly	Stockholm
July	4	Biometrics Society Symposium	São Paolo
"	12	Economic and Social Council - 20th Regular Session	Geneva
"	13	2nd International Seaweed Symposium	Trondheim
"	18	International Whaling Commission - 7th Meeting	Moscow
"	21	International Union of Pure and Applied Chemistry - 18th General Conference, 14th International Congress (Organic Chemistry)	Zurich
August	1	3rd International Congress of Biochemistry	Brussels
"	31	9th International Congress on Refrigeration	Paris
"		Economic and Social Council - 20th Session resumed	New York
September	10	Symposium on Geographical Factors in the Development of Tropical Africa (Food and Population, Land Use Survey)	Kampala
"	30	Indo-Pacific Fisheries Council - 6th Meeting	Tokyo
October	24	International Council for the Exploration of the Sea	Copenhagen
November	4	FAO Conference - 8th Session	Rome
November		International Council of Scientific Unions - 7th General Assembly	Oslo
		Gulf and Caribbean Fisheries Institute	
		International Commission for the North Pacific Fisheries	

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	General Fisheries Council for the Mediterranean	Turkey
	13th Limnological Congress	Finland
	U.N. Statistical Commission - 9th Session	U.S.A.
	3rd International Canning Congress	Italy
	FAO Fisheries Technology Meeting	
	FAO International Congress of Fishing Gear and Methods	
	International Union of Geodesy and Geophysics	Canada
	Gulf and Caribbean Fisheries Institute - Meeting	

Training Centers

1955

September	FAO/ETAP International Training Center in Fish Culture	Djakarta/ Bogor
September/ October	FAO/ETAP International Training Center on Fisheries (Administration)	Copenhagen

ED. NOTE. All dates are subject to revision.

Third FAO Regional Meeting on Food and Agricultural Programs and Outlook in Latin America

The Third FAO Regional Meeting on Food and Agricultural Programs and Outlook in Latin America took place in Buenos Aires from 1 to 10 September 1954 at the invitation of the Argentine Government.

The Meeting examined the present situation in Latin America regarding food production, distribution and consumption, and other agricultural products including fisheries, and studied the supply and demand outlook as planned up to the agricultural year 1956/57. In the light of this outlook, recommendations were made for the formulation of national production and consumption policies and programs, also measures tending to improve and strengthen the organizations and the means by which these programs might be implemented.

Delegations attended from Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, France, Guatemala, Haiti, Honduras, Mexico, Nicaragua, the Netherlands, Panama, Paraguay, United Kingdom, United States of America and Uruguay. Observers were present from the following international organizations : United Nations (Economic Commission for Latin America) ; International Labour Office ; Organization of American States (Inter-American Institute of Agricultural Sciences) ; Inter-governmental Committee for European Migration ; The Holy See ; Inter-American Trade and Production Committee ; Catholic Women's Association.

Dr. B.F. Osorio-Tafall, FAO Regional Fisheries Officer for Latin America, reported on FAO's work to further Latin American fisheries.

A document in which the general situation and the factors limiting fisheries development in the region was considered, studied and approved. The importance of increased production and consumption of fish for improving the nutrition of the population rapidly and without great capital outlays was recognized and it was agreed that in spite of considerable development in the fishing industries during recent years, there are still many zones in Latin America which offer great possibilities for the wider use of potential fisheries resources.

It was agreed that the promotion of fisheries was as dependent upon the development of production through modernization and mechanization of craft, equipment and fishing methods as it was on the improvement of marketing fish products ; the need for technicians and specialists in the different branches of the industry, as well as the need for strengthening or organizing fisheries administrations, was felt to be of prior importance.

Information was given on the excellent results achieved in some Latin American countries, with the technical assistance of FAO, by the breeding of fish in ponds and the better utilization of inland waters, together with the balancing of the diet in rural communities, by means of fish culture.

The Meeting noted that FAO has organized regional fisheries councils in various parts of the world to establish contact between fisheries experts and to assist in the development of fisheries.

In 1950, a resolution was adopted by the Second FAO Latin American Regional Meeting on Food and Agricultural Programs and Outlook, to establish a Latin American Fisheries Council. In 1951, a meeting was held to organize this Council at which most countries of the region were present and an agreement for the constitution of the Council was drafted. Although this agreement was approved by the Sixth Session of the FAO Conference[1] for submission to interested governments for ratification, the Director-General of FAO has not yet received sufficient notifications or ratifications for the formal establishment of the Council.

The Meeting agreed that the establishment of the Latin American Fisheries Council would constitute an essential step in the proper development and rational utilization of the marine and inland fisheries resources of the region and it recommended that the regional governments should adhere to the agreement establishing the Council at the earliest possible date. A draft resolution was submitted to the Meeting urging interested governments to ratify the agreement.

As it was considered desirable that some of the functions of the proposed Council should be initiated provisionally, pending ratification, it was resolved that the Director-General of FAO should be asked to seek authority of the Conference, under the Rules of Procedure of the Organization, to enable him to establish a regional commission for Latin American fisheries, to be made up of sub-commissions established according to geographical areas and fisheries of common interest, and when so authorized, to proceed with the establishment of such a regional commission provided this appears to him expedient.

Finally, it was agreed that as from 1955, and under the Technical Assistance Program, FAO should organize, in those countries of the region best able to provide the necessary facilities, training centers of a more specialized character to cover the technical problems of fisheries, to ensure the most rational use of existing resources, and the improvement of the nutrition of the people. One center should be devoted to fisheries biology, one to technology, and a third to economics and fisheries administration. It was also agreed that FAO and other Specialized Agencies should grant fellowships so that these centers could be attended by the greatest possible number of representatives from interested countries.

Selective Expansion of Production and Consumption in the Near East

In accordance with a recommendation by the FAO Conference that inter-governmental consultations on a regional level should be held, the first such consultation, on the Selective Expansion of Production and Consumption in the Near East, took place in Beirut, Syria, 13-16 September 1954.

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[1] *See FAO Fisheries Bulletin* IV (6), 21.

Representatives, or observers, attended from Egypt, France, Iran, Iraq, Lebanon, Pakistan, Sudan, Syria, Turkey, the United Kingdom and Yemen. The League of Arab States, the United Nations, the International Labour Office, the United Nations Children's Fund (UNICEF), the United Nations Relief and Works Agency (UNRWA), the Near East Foundation and FAO, were also represented.

The meeting was conceived as a gathering of policy makers and the number of technical experts present was small. They included the Chief of the Fisheries Section at the Ministry of Agriculture, Lebanon, Mr. Rafaat El-Zein, and the Acting Senior Inspector of Fisheries, Sudan Ministry of Animal Resources, Mr. Hassan Mohammed Ibrahim. The meeting carried out an exhaustive review of consumption and production policies pertaining to food and agricultural products, including fisheries products. The basis of the discussions was two working papers, one of which was specifically concerned with fisheries development.

Reference was made to the programs under way or being planned for increasing the production and consumption of fish. The merits of inland fisheries as an effective source of additional proteins were stressed and ways and means of protecting and developing the resources were mentioned. Interest was also shown in the possibilities of expanding marine fisheries in the region.

F.E. Popper, FAO Fisheries Division member of the Secretariat, introduced the fishery paper as a supplement to the working paper, and there was general agreement with the principles of development which it set out, in particular with the emphasis placed on the role to be played by efficient fisheries administrations. Plans for FAO assistance in the training of fisheries administrators were noted with satisfaction.

International Rice Commission

Fish Culture in Rice Fields

The 4th Session of the Commission was held in Tokyo, Japan, from 11 to 14 October 1954.

Two sessions were devoted to the subject of fish culture in rice fields, at which the Fisheries Division was represented by Dr. S. W. Ling, seconded from his FAO/ETAP assignment in Thailand. The Commission had before it a working paper entitled "The Use of Rice Fields for Fish Culture," prepared by W. H. Schuster, which gave a general account of the opportunities for the employment of this technique, and of the practices themselves. The paper summarized current views on the advantages and disadvantages of this technique and drew attention to problems on which research work should be carried out.

Certain Member Governments of the Commission presented experience papers in answer to a questionnaire, submitted by the Fisheries Division, intended to elicit practical information on the extent to which this culture is practised and the methods used,

Opening a discussion on the subject, Dr. Ling briefly described the methods in use and the species cultivated. He referred to the choice of species for different environments and for different rice culture regimes, to feeding methods and yields, and he drew attention to the social and economic aspects of the practice and to the continued lack of information on certain fundamental points, especially in the biological field. A number of color slides were then presented illustrating current Japanese methods.

Discussions took place during the second session. The representative of the United Kingdom spoke on the paper by Soong Min Kong, presented by his delegation, which described fish culture in paddy fields in the Federation of Malaya. The area of paddy lands in the Federation is 386,400 ha., of which the greater part (360,000 ha.) is under wet cultivation, but only 136,400 ha. are supplied with controlled irrigation and drainage ; furthermore, of the latter area, only 45,000 ha. are capable of being flooded to a depth of 25 cm. or more for a period of 100 days during the planting season. From the paddy areas the total fish production is estimated to be 7,500 metric tons, but this estimate excludes local (subsistence) consumption.

Principal species cultivated are Sepat Siam (*Trichogaster pectoralis* Regan), Keli (*Clarias batrachus Linnaeus*), Aruan (*Ophiocephalus striatus* Bloch), Sepat ronggeng (*Trichogaster trichopterus* Pallas) and Betok (*Anabas testudineus* Bloch).

The ' culture ' practice is based on the establishment of permanent stocks of fish, chiefly *Trichogaster pectoralis*, in adjacent perennial waters which enable them to pass into the paddy fields ; sumps are dug in the paddy fields to act as trapping placers, and as permanent refuges for the breeding stock. Once the fish are established in the permanent waters, stocking of the flooded fields is done naturally, and it is believed that the fish have a beneficial effect on the paddy. Yields as high as 200 to 400 kg. per ha. have been obtained, while from some areas the yields are as low as 10 to 50 kg. per ha. Carp is not cultivated. Attempts have been made to use *Tilapia mossambica*, but these have failed, it is believed, because of predation by *Ophicephalus striatus* and *Clarias batrachus*.

The cultivation of Tilapia in the rice fields of Taiwan (Formosa) was discussed in a paper by Tung-Pai Chen, who pointed out that although Tilapia is grown on about 8,000 ha. and yields 6,300 metric tons (its quantity is the fourth largest among Taiwanese fresh-water fish), its culture has presented many difficulties. The climate is unfavorable and allows a growing season of only seven months. Moreover, this climate limits the spawning of the Tilapia which waits until late spring for the water temperature to reach a suitable level ; consequently it is difficult to provide fry for the spring planting. Drought presents another hazard. And finally, owing to its high reproductive rate, overcrowding occurs and growth is seriously hampered.

Some details of fish culture in paddy fields in India were given by Ramaswamy and Saha. In Indonesia, approximately 50,000 ha. of paddy fields are used for fish culture. The species cultivated are

ikan mas (*Cyprinus carpio*), ikan mudjair (*Tilapia mossambica* Peters), ikan nilem (*Osteochilus hasselti* C.V.), Tambakan (*Helostoma temmincki* C.V.), and ikan tawes (*Puntius javanicus* Blkr).

An account of carp culture in rice fields in Japan was presented by Katsuzo Kuronuma. About 9,000 ha. of paddy fields are used and yield approximately 1,200 metric tons. Limited cultivation of other species has been undertaken but it was noted during the discussion that there had been a decline in their culture in recent years possibly due to the high price of feeds. Kuronuma described the prerequisites of carp culture in rice fields and the construction of the fields necessary to meet these requirements. He gave an account of the procuring of eggs and the rearing of fingerlings, and described, in detail, the methods of rearing fish for market and of 'wintering' the stock. Although the profit on fish culture is lower than that on rice (60% against 150%), the fish is regarded as an important side crop.

Notes on the cultivation of *Cyprinus carpio* in Italian rice fields were presented by Professor Giovanni Sampietro.

After the discussions the Commission recommended that Member Governments be advised of the desirability of formulating a program of investigation of the problems of this work, and it suggested that the Indo-Pacific Fisheries Council should give attention to the technical aspects of these problems.

General Fisheries Council for the Mediterranean (GFCM)

The third meeting of the Council was held in the Principality of Monaco from 14 to 19 October 1954, under the chairmanship of Professor U. D'Ancona (Italy). H.E. the Minister of State of the Principality welcomed delegates at the opening plenary session. Dr. D.B. Finn, Director of Fisheries Division, FAO, on behalf of the Director-General, Dr. P.V. Cardon, spoke on the scope of FAO activities and the role of the Council in these activities. M. Girard (FAO) attended in his capacity as Secretary to the Council.

Delegations attended from France, Greece, Israel, Italy, Monaco, Spain, Tunisia, Turkey and Yugoslavia, and observers represented the International Hydrographic Bureau, Monaco; the Indo-Pacific Fisheries Council; the International Council for the Exploration of the Sea; International Commission for the Scientific Exploration of the Meditarranean and FAO.

Professor D'Ancona was re-elected chairman and C. Serbetis (Greece) and T. Soljan (Yugoslavia) were re-elected 1st and 2nd vice-chairmen, respectively. Officers elected to the five technical committees are as follows:

Exploration Committee	Chairman: M. Furnestin (France) (Mr. Furnestin has since resigned and a new appointment will be made in due course); Vice-Chairman: U. D'Ancona (Italy); Rapporteur: G. Belloc (Monaco).

Production Committee	Chairman : T. Soljan (Yugoslavia) ; Vice-Chairmen : M. Shavit (Israel), A. Ferragut (Spain) ; Rapporteur : O. Saix (France)
Utilization Committee	Chairman : C. Serbetis (Greece) ; Vice-Chairman : R. Dieuzeide (France) ; Rapporteur : R. Mikulič (Yugoslavia).
Statistics Committee	Chairman : C. Solamito (Monaco) ; Vice-Chairman : M. Zupanovič (Yugoslavia) ; Rapporteur : R. Cusmai (Italy).
Inland Waters Committee	Chairman : U. D'Ancona (Italy) ; Vice-Chairman : R. Charpy (France) ; Rapporteur : K. Kosswig (Turkey).

An application for membership was received from Spanish Morocco and will be presented to the next FAO Conference for approval.

A Joint Committee was created to co-ordinate and define the programs of the Commission for the Scientific Exploration of the Mediterranean Sea and the Exploration Committee of the Council.

Fifty-four papers were presented and the proposals of the committees were submitted to the final Plenary Session on 19 October. Programs of work were made as short and precise as possible in order to restrict the fields of study and it was agreed to give priority consideration to the specific matters in each committee.

Exploration Committee

Priority will be given to studying :

Clupeidae
- (*a*) a map of the quantitative distribution of eggs together with an indication of hydrological conditions;
- (*b*) the intensification of critical studies with a view to a correct determination of age and growth ;
- (*c*) the improvement of fishery statistics for the purpose of obtaining accurate data on the quantities landed and the means used ;
- (*d*) convening a meeting of the experts concerned, before the next meeting of the Council, if the material assembled justifies such action ;
- (*e*) requesting the International Commission for the Scientific Exploration of the Mediterranean to stimulate research in hydrology, particularly the study of currents about which little is known ;
- (*f*) publishing an illustrated description of the working techniques recommended in view of their standardization.

Thunnides
- (*a*) bathymetric and geographic distribution of various species ;
- (*b*) nourishment and sexual phases ;
- (*c*) migrations.

Edible crustaceans. The study of the Peneidae (Aristeus-Aristomorpha) and Pandalidae groups, the area of distribution and their biology in the meso-abyssal zone of the Mediterranean.

Study of trawling grounds. A special commission of experts from interested countries to make a map for each country of the grounds at present being exploited by trawlers, which are, or can be, fished by trawlers, including the meso-abyssal zone, the trawling of which is recommended. The map will indicate the local names under which the various fishing grounds are designated, their sizes, the nature of the bottom and characteristic animals living there, the main species of fish and edible crustaceans found, the most favorable trawling season and the estimated return of a boat of a certain type.

Production Committee

Priority will be given to :

(*a*) full participation in the world survey of living aquatic resources, and in the meeting on gear technology, to be held under the auspices of FAO ;

(*b*) the distribution of a questionnaire to all Mediterranean countries (including non-members), from which fishing boats (particularly gear and methods) can be classified, the results to be submitted to the next meeting of the Council in analytical and summarized form ;

(*c*) co-operation in the study of the fisheries of Mediterranean countries ;

(*d*) making a comparative study in fisheries administration and regulations of the present situation, experience and proposals to be undertaken ;

(*e*) collecting data for the compilation of the " Mediterranean Fisheries Map " in co-operation with the Exploration Committee ;

(*f*) obtaining from member countries particulars of problems and prospects regarding the safety and working conditions of fishermen.

Utilization Committee

Priority will be given to :

(*a*) studying methods of improving fish and crustacean refrigeration by the use of ascorbic acid, antioxidizers and antiferments ;

(*b*) making a comparative study of sardine refrigeration by crushed or pounded ice from fresh or sea water ;

(*c*) making an economic study of sardine refrigeration or freezing by water and air refrigeration ;

(*d*) studying the best economical and technical conditions for the freezing of sardines, mackerel and tuna ;

(*e*) studying the use of antioxidizers and drying of fish for transportation ; ways of using fish offal of salted sardines

for conversion into by-products ; and an economical method, for use at sea or on land, of treating small quantities of fresh fish or offal ;

(*f*) making an economic analysis of the various methods of processing sardines, and a study of economic low capacity plant for use in small fishing ports.

In addition, the resolutions formulated at the second meeting (Rome, 26-29 October 1953) concerning the refrigeration at sea and in the fishing industry to ensure continuity of refrigeration, an institution to control quality in each country, and a study of various technical methods of preparing fish by machinery, were reiterated as being of particular importance.

Statistics Committee

The Committee will in future be called " Economics and Statistics Committee " and will include in its activities a general study on fisheries economics to serve as a basis for future activities.

Inland Waters Committee

Priority will be given to :

(*a*) pollution of water – study to be confined to one type of factory only ;

(*b*) valliculture – a paper will be prepared by Professor D'Ancona on the biology of grey mullet ;

(*c*) carp culture :

- (*i*) concentrating on increasing the knowledge of the physiology of the production of fish in ponds ;
- (*ii*) studying the physiology of the nutritional processes of carp accurately ;
- (*iii*) studying extensively the fertilization of ponds ;
- (*iv*) improving the breed of carp used by the application of genetic principles ;
- (*v*) studying fish diseases (especially ascites) ;
- (*vi*) studying the relations and balance between phytoplankton and fish, taking into account lakes, open water and especially lagoons.

(*d*) fisheries in barrage lakes – the study of the most effective fisheries for the steadily increasing lakes whose biotic and biologic conditions are rapidly changing and about which there is insufficient knowledge ;

(*e*) salmon culture – the study of the most effective feeding of fish reared in ponds ; to the production of sufficient fry to ensure stocking of barrage lakes and open waters adequately for future consumption ; to the building of transport to carry fry from hatcheries to fish farms ; and to the transporting of live fish from fish farms to consumer areas.

The Council was invited by the Turkish delegation to hold its next meeting in Istanbul, Turkey, some time in the autumn, 1956.

International Commission for the Scientific Exploration of the Mediterranean Sea

The Commission held a meeting from 20 to 23 October 1954 in the Principality of Monaco at which representatives attended from France, French Morocco, Greece, Italy, Monaco, Spain, Spanish Morocco, Tunisia and Yugoslavia. M. Girard represented FAO and the General Fisheries Council for the Mediterranean (GFCM).

Ambassador Sola (Italy) was re-elected chairman and Professor Petit (France) was elected Secretary General.

The meeting considered the organization of the Commission and its program of work.

International Council for the Exploration of the Sea (ICES)

The 42nd Meeting of the Council took place in Paris, from 4 to 12 October 1954, under the presidency of A.T.A. Dobson (U.K.). Some 125 participants, comprising delegates and experts from Member Governments, and observers attended from the Permanent Commission of the International Fisheries Convention of 1946; the International Whaling Commission; the International Commission for the Northwest Atlantic Fisheries; the International Commission for the Exploration of the Mediterranean Sea; the Woods Hole Oceanographic Institution; the Fisheries Research Board of Canada; the Australian Scientific Liaison Office, London; the General Fisheries Council for the Mediterranean; the Indo-Pacific Fisheries Council, and FAO (represented by Dr. G.L. Kesteven).

The many reports were considered in sessions of the Council's committees and in three special scientific meetings. These latter dealt with:

(*a*) problems and methods of sampling fish populations;

(*b*) oyster and mussel culture, and

(*c*) herring tagging techniques and results.

Of particular interest were the papers presented to the Comparative Fishing Sub-Committee which included accounts of recent important technical developments in equipment for studying the behavior of fishing gear in operation.

The Council resolved to establish two new committees concerning (*i*) gadoid fish, and (*ii*) comparative fishing. To permit the formation of these committees, it was resolved

> that *the North-eastern and North-western Sub-Committees should be combined into a "Distant Northern Seas Committee*;"

that *the North Sea Committee, the Transition Committee and the Baltic Committee should be replaced by the "Near Northern Seas Committee" and the "Baltic Belt Seas Committee";"*

that *the Northern Seas Committee and the Pelagic Committee should be abolished*;

that *the European Slope Sub-Committee and the African Slope Sub-Committee of the Atlantic Committee should be abolished and replaced by two full committees: the Sardine Committee and the Scombriform Fish Committee*;

The Council decided to make certain readjustments in the definition of the boundaries of the areas of interest of its area committees.

FAO had submitted to the Council a statement on its plans for a world survey of living aquatic resources, and it was resolved to place at the disposal of FAO such information and publications as might be available, and to ask the Secretariat to put FAO in touch with expert members of the Council who might be able to assist them in this work.

It was recorded that FAO was examining the problem of bibliographic services for fisheries.

A.T.A. Dobson was re-elected President of the Council; Professor H.U. Sverdrup was elected first vice-president and J. Furnestin and G.J. Lienesch were elected second vice-presidents. R.S. Wimpenny was re-elected Chairman of the Consultative Committee and Commander J.R. Lumby as editor of the journal.

Commonwealth Oceanographic Conference

On the initiative of the National Oceanographic Council of the United Kingdom, a Commonwealth Oceanographic Conference took place at the National Institute of Oceanography (NIO), Wormley, Surrey, England, from 18 to 22 October 1954.

This conference was attended by representatives from Australia, Canada, India, New Zealand, and Pakistan; Ceylon and South Africa sent observers. Delegates from the United Kingdom included representatives of government departments, the Development Commission, the British Museum (Natural History), the Royal Society and the Scottish Marine Biological Association and the Marine Biological Association of the United Kingdom.

The object of the conference was to consider the possibility of closer co-operation in oceanographic research throughout the British Commonwealth. The need for such co-operation has become more pressing in recent years, because the tendency in oceanography has been to devote more and more effort to theoretical studies in an attempt to understand the fundamental physical and biological processes which are responsible for, and cause variations in, the properties of the waters, rather than to collect and analyse data concerning water movements, temperature, chemical properties, distribution of marine life, etc., formerly the main activity. This change in approach has increased the difficulty of oceanographic laboratories in finding sufficiently quali-

fied staff and providing the necessary facilities. The problems to be solved call for the attention of physicists of the highest caliber, and it will be a long time before any single country can interest an adequate number of such men in marine problems. Furthermore, it is becoming increasingly expensive to build, equip and operate a marine ocean-going research vessel.

The discussions of the conference were organized under five principal headings :

1. *The objects and value of oceanographic research.* To assess the value of past and future oceanographic research to defence, fisheries, marine biology, shipping, coastal engineering, meteorology, submarine geology and natural science as a whole.
2. *Division of effort between basic and objective research.* To judge the extent to which demands for individual answers to one local problem after another should be met by research on the basic principles which underlie them all.
3. *Progress and planning of oceanographic research.* To seek and outline the views of the Conference on the allocation of effort between such aspects as :
   (*a*) collection of data,
   (*b*) charting and publication of data,
   (*c*) description of particular features,
   (*d*) search for theories to explain particular features,
   (*e*) theoretical and experimental work on type problems.
4. *Problems of special interest to Commonwealth countries.* To discuss topics in which oceanographers in Commonwealth countries are most interested, including discussion of ways and means as well as scientific problems. Subjects, such as staff qualifications, equipment and methods, information and research ships, were dealt with.
5. *Administrative arrangements to facilitate co-operation.* To discuss questions such as exchange of information, equipment and staff, sharing of research vessels and other facilities, and the division of work on mutual problems.

The Conference concluded that there was scope for increased practical application of oceanographic research. It agreed on the more important fields of study which require a concerted attack in order to obtain an understanding of the basic physical and biological processes involved, and endorsed the NIO's program of research in these fields. Agreement was also reached on the need to share equipment, exchange staff and information and increase the facilities for training staff. It was also proposed, where necessary, to set up machinery for furthering co-operation.

The report of the Conference will be published by the National Oceanographic Council.

Meeting of Experts in Marine Biology Organized by the Center for Scientific Co-operation in Latin America of UNESCO and by FAO[2]

The Meeting of Experts in Marine Biology in Latin America, organized by UNESCO with the collaboration of FAO, took place in the Department of General Biology of the University of Concepción, Concepción, Chile, from 15 to 17 September 1954, and was attended by delegates from Argentina, Brazil, Chile, Cuba, Mexico, Peru, Venezuela and Uruguay. Representing UNESCO were Dr. Angel Establier, Director of the UNESCO Center for Scientific Co-operation in Latin America and Lennart Mattsson of the same office ; Horacio Rosa Jr., Assistant Fisheries Officer for Latin America, represented FAO.

The meeting recorded its view that marine biological research in Latin America should be developed, and proposed that, for such development to be accelerated, a commission be set up to co-ordinate all marine biological and oceanographic activities, that a number of marine biological laboratories be established, and that a scheme be set in motion for the full-time employment of experts in marine biology. Suggestions were also made that a directory of institutes be compiled, various symposia organized, and other steps taken to stimulate interest in marine biology.

1954 Session of the International Permanent Committee on Canned Foods (CIPC)

The meeting took place at the Swedish Institute for Food Preservation Research, Kallebäck, Göteborg, Sweden, from 27 September to 2 October 1954, with the President, M.R.V. Manaut, in the chair.

There were some 50 delegates and advisers from Belgium, France, Western Germany, Morocco, the Netherlands, Portugal, Sweden, Switzerland and the United Kingdom and observers from Denmark, Norway, the Tin Research Institute, and FAO.

The program covered a 4-day meeting with an opening, plenary session on 28 September, and a closing plenary session on 1 October. Between these meetings the delegates split up into the standing commissions, usually 2 to 3 commissions debating at the same time. The Scientific Commission, the Commission for Standardization of Cans for Fish, the Commission for Regulation and Definition of Canned Fruits and the Commission for Regulation and Definition of Canned Meat held two meetings each, while the Commission for Standardization of Round Cans, the Commission for Regulation and Definition of Canned Vegetables and its Sub-Commission on Cultivation, the Commission for the Regulation and Definition of Canned Fish, the Commission on Propaganda and Statistics, the Commission on Machines and Equipment, the Commission for the Planning of the Third International Congress on Canned Foods and the Finance Commission held one meeting each.

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[2] *See FAO Fisheries Bulletin*, VII (1), 32 ; (3), 129 ; (4), 188.

Scientific Commission

Under the heading "Bacteriology," research work carried out in a number of member countries on the bacteriology of semi-preserved marinades, on sterilization of spices and on bacteriological definitions of canned foods, e.g. semi-preserved canned hams, was discussed.

Under the heading "Standardization of Analytical Methods," the determination of dry matter in tomato pastes, and of total nitrogen, tin and small quantities of SO_2 in canned foods, was discussed, as well as ways and means of co-operating with the American Association of Official Agricultural Chemists (AOAC) work of standardizing analytical methods.

The CIPC has made an *International Survey of the National Legislations on the Use of Preservatives in Foods*. This survey will be published in the near future. A similar survey on the use of artificial coloring in foods has also been made, but publication will be delayed as many countries are amending their legislation in this field. Both surveys will be issued in loose-leaf form.

Commission for Standardization of Cans For Fish

A list of 12 sizes (capacity in mililiters) for round cans ranging from 85 to 1,700 ml. was approved for recommendation to the International Organization for Standardization (ISO).

In addition to the already standardized rectangular "Club 125" can, the so-called 1/15 P can was discussed and a standard capacity of 50 ml. $\pm$ 5% was adopted, and a length of 97 $\pm$ 2 mm. and width of 44 $\pm$ 2 mm. was recommended.

It was decided to give further study to the standardization of the $^1/_4$ Dingley can and a standard capacity of 118 ml. $\pm$ 5% was suggested.

Commission for the Regulation and Definition of Canned Fish

In this Commission problems of using frozen sardines for subsequent canning were discussed, as well as the necessity of standardizing declarations of weight of contents on the labels of canned fish, the necessity of standardization of the definition of marinades in various languages, the definitions of tunas and the use of preservatives in the handling and processing of fish for subsequent canning.

Commission for the Organization of the Third International Congress on Canned Foods

This Congress will take place in September 1956, in Italy, in conjunction with the Canned Foods and Packaging Fair of Parma. The Canning Congress may be held in Rome or Parma depending on the decision of the host country. A 5-day meeting is planned and the tentative program was established after a lengthy discussion. This will cover summaries of reports on the CIPC activities, reports on advances in canning technology, sessions on packaging (containers) and machinery methodology of market investigations, economics of canning, waste and pollution problems, public health and educational (propaganda)

aspects, canned foods and nutrition, and finally, bacteriological problems and definition of canned foods.

FAO/CIPC Relations

The FAO observer took part in the discussion of the Scientific Commission and the Commission for the Regulation and Definition of Canned Fish when FAO/CIPC co-operation was informally discussed. A more formal discussion had been planned for the final plenary meeting, but had to be postponed till the next session of the CIPC which is to take place in Paris in the autumn of 1955.

Nutrition - Symposium

Following the CIPC meeting, the Swedish Institute for Food Preservation Research organized a 3-day symposium on "Nutritive Aspects of Preserved Food," with over 20 contributors of reports and over 60 participants from Denmark, France, Western Germany, Norway, Sweden, Switzerland, the U.K. and the U.S.A. The reports, but not the discussions, will probably be issued in printed form at a later date.

127th Session of the Governing Body of the International Labour Office (ILO)

There were two items of particular interest to fisheries on the agenda of the 127th Session which took place in Rome, Italy, from 16 to 19 November 1954. They were the report of the Joint ILO/WHO Committee on the Hygiene of Seafarers, and the report of the Committee of Experts on Conditions of Work in the Fishing Industry. Discussion was deferred, however, to the next session to enable delegates to study these reports.

The Joint ILO/WHO Comimttee has agreed that four questions relating to conditions of work in the fishing industry should now be considered on an international basis. These are :

1. mimimum age of entry ;
2. medical examination on entry and periodically thereafter ;
3. articles of agreement ;
4. accident insurance.

The Committee recommended that these points should be referred to the Joint Maritime Commission with a view to including them in the next Maritime Session of the International Labour Conference.

The Committee also felt that there were a number of other questions concerning conditions of work in the industry which should be considered, i.e. safety of fishermen at sea and on board ; certificates of competency of fishermen ; unemployment insurance of fishermen ; sickness insurance for fishermen ; accommodation on board fishing vessels ; medical care on board fishing vessels ; vocational training for fishermen.

The Committee accordingly recorded a request to the governing body to instruct the Director-General to consider these questions and to bring forward suggestions concerning future action, including the possibility of convening another session of a committee of experts.

Fisheries Division Activities

The Program of Work of the Fisheries Division

Many people who are interested in fisheries or have everyday concern with the subject in one or other of its phases and who may be readers of this bulletin have, perhaps, not had the opportunity of learning much about the work of the Fisheries Division. It is thought useful, therefore, to introduce a series of short explanatory articles upon the programs of work of the Division which will appear in subsequent issues of this bulletin, to explain how they came about, and to show how they are performed.

To make the subject clear, it is necessary to know something about the Organization itself and why it exists. Following World War II, nations came together to collaborate in the raising of nutrition and standards of living of their peoples. The inter-war experience had shown, as was revealed at the Hot Springs Conference in 1943, that there are problems in connection with food production, distribution and consumption that nations could not resolve by acting independently (1). Accordingly, as a result of the work of an Interim Commission on Food and Agriculture, these nations formed the Food and Agriculture Organization of the United Nations in 1945, which today consists of a body of 71 nations operating under a Constitution giving it a separate entity (2). It had its temporary headquarters in Washington, but in 1951 moved permanently to Rome. Its governing body is the Conference which is made up of the plenipotentiary delegates of its Member Governments. The Conference meets biennially but a Council of 24 member nations, to which the Conference delegates certain authority, meets twice a year. Its chief executive officer is the Director-General, who is appointed by the Conference. He is assisted by a Deputy Director-General, a Secretary-General and the Directors of the Divisions of Agriculture, Economics, Fisheries, Forestry, Nutrition, Administration, and Information. Regional Offices are maintained in the Near East, in Cairo, Egypt ; the Far East, in Bangkok, Thailand; North America, in Washington, D.C U S A. ; Latin America, in Rio de Janeiro, Brazil, with Branch Offices in Santiago, Chile, and Mexico City, Mexico.

The functions of an international organization in the field o food and agriculture were first considered at a conference which met at Hot Springs, W. Virginia, U.S.A., in 1943. But here only the broad principles were laid down. This Conference established an Interim Commission which, during the next two years, drafted a set of general functions and which now appears in Article I of the Constitution (2).

Functions of the Organization

1. The Organization shall collect, analyze, interpret, and disseminate information relating to nutrition, food and agriculture. In this Constitution, the term "agriculture" and its derivatives include fisheries, marine products, forestry and primary forestry products.

2. The Organization shall promote and, where appropriate, shall recommend national and international action with respect to:

(*a*) scientific, technological, social, and economic research relating to nutrition, food, and agriculture;
(*b*) the improvement of education and administration relating to nutrition, food, and agriculture, and the spread of public knowledge of nutritional and agricultural science and practice;
(*c*) the conservation of natural resources and the adoption of improved methods of agricultural production;
(*d*) the improvement of the processing, marketing, and distribution of food and agricultural products;
(*e*) the adoption of policies for the provision of adequate agricultural credit, national and international;
(*f*) the adoption of international policies with respect to agricultural commodity arrangements.

3. It shall also be the function of the Organization:

(*a*) to furnish such technical assistance as governments may request;
(*b*) to organize, in co-operation with the governments concerned, such missions as may be needed to assist them to fulfill the obligations arising from their acceptance of the recommendations of the United Nations Conference on Food and Agriculture and of this Constitution; and
(*c*) generally to take all necessary and appropriate action to implement the purpose of the Organization as set forth in the Preamble.

It will be noted that these functions are limited to those of a deliberative and advisory body in which governments may report to one another upon problems encountered and progress made, but which has no executive functions in respect of its Member Governments.

In addition to this, the Interim Commission established a special technical committee whose task was to report upon the application of these functions to the field of fisheries. This report (3), which was subsequently adopted in 1945, described the subject matter and the kind of international action and collaboration that was necessary for an orderly fisheries development and became the terms of reference for the Fisheries Division. These terms of reference set out broad fields of work, but did not describe a program of work or an initial approach. There were, of course, many courses of action that could have been taken, but the task which confronted the Director-General was to set priorities to bring the proposed actions within the compass of the means. To assist him in this, he appointed a Fisheries Standing Advisory Committee. This Committee, whose members were Dr. D. J. Van Dijk (Netherlands), Chairman; Mr. Ray Gushue (Newfoundland), Vice-Chairman; Dr. A.W.H. Needler (Canada); Mr. B. Dinesen (Denmark); the Hon. Thor Thors (Iceland); Dr. Baini Prashad (India); Mr. Klaus Sunnanaa (Norway); Dr. C. von Bonde (Union of South Africa); Mr. P.D.H. Dunn (U.K.); and Mr. A.W.

Anderson (U.S.A.), undertook, together with the Secretariat, the formulation of an initial program of work for the Fisheries Division.

It was recognized that relatively little attention had been given to fisheries by governments and educational institutions. Its development had lagged a long way behind agriculture in the rate of increase in its productive capacity and efficiences. Scant attention had been paid to its internal economics or the place of fisheries in the over-all economic picture. There were no fisheries statistics worthy of the name in many countries and no attempt had been made to collect and summarize on a world basis those statistics which were available. Attempts to catalogue the existence of the fisheries resources had not yet been made and the natural laws governing the fluctuations in abundance and availability were imperfectly understood. Industrially, its technology fell far behind many other food producing industries. In fact, fisheries taken in general, with few exceptions, was in the primitive stage of hunting the wild stocks for its raw material in an unmanaged way, while industrially it lacked the knowledge, the incentives, the capital and the recognition required for progressive development. It was recognized that there were many cogent reasons for this backwardness and that the problems which it posed were of an extremely intricate nature. It was the opinion of the Member Governments of FAO that international co-operation would help to remove some obstacles and that the solution of others would depend upon the evolution of progressive national policies based upon sound information. It was also recognized that as world population grew and as agriculture approached the ultimate limits of its production, man's efforts would more and more be turned by the necessity for increasing food supplies to the exploitation of the waters of the land and the sea.

This, then, was the nature of the task that confronted FAO, where for the first time in history an international organization had been given a general fisheries reference. It was a complex problem no part of which was entirely unrelated to the other and each part having its biological, technological and economic facets. With these considerations in view, the Standing Advisory Committee recommended the organization of the Division into three Branches, namely Biology, Technology, and Economics and Statistics, whose work should be guided by long-term objectives but whose immediate approach should be limited to the more important parts of those objectives. Thus, the regular program of the Division was constituted. It is financed by an annual budget voted by the Conference, the share of the Fisheries Division being U.S.$184,000 in 1947, rising to U.S.$465,000 in 1954, while the total budget for the whole Organization was originally U.S.$5 million, rising to U.S.$6 million in 1954.

In 1951, funds became available from the Technical Assistance Board and it became possible to assist underdeveloped countries to a much greater extent. This made it necessary to add Technical Assistance officers and staff to the Director's Office of the Division, to be responsible for the planning and administration of this field of work. This staff, in co-operation with the Branches, brings to bear the accu-

mulated experience of FAO to the direct aid of individual governments for fisheries development. The amount of money devoted to the technical assistance work varies from year to year, depending upon the amounts made available by the contributing nations. In 1953 and 1954, it was slightly over $6 million and the same amount is expected for 1955. The Fisheries Division's share of this rose from $390,000 in 1952 to some $400,000 in 1954.

It says much for the work of the Fisheries Standing Advisory Committee that the foundation laid by them has endured through ten years of enquiry by succeeding FAO Conferences and that upon it has been built the programs of today. These programs, as mentioned previously, will be described in articles of this Bulletin that are to follow and will illustrate how, by international co-operation, nations have put into motion work to assist in the full and wise utilization of fisheries resources.

REFERENCES

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(2) 1952 *Constitution, Rules and Regulations of the Food and Agriculture Organization of the United Nations.* FAO, Rome, Italy.

(3) 1945 *Report of the Technical Committee on Fisheries submitted to the United Nations Interim Commission on Food and Agriculture.* April 13, 1945. Washington.

(These publications are available from FAO Headquarters, Rome, Italy).

Expanded Technical Assistance Program

Resumé of progress in fisheries.

Category I Programs 1954-55

Brazil W.E. Ripley (U.S.A.), seconded from the California Department of Fish and Game, after briefing in Rome in December, has assumed duty in Brazil as a marine biologist. He is carrying out an appraisal of underdeveloped fish resources, with a view to increased exploitation. A master fisherman will also assume duty there as soon as he is released from his present employment. Both experts will work throughout 1955, and will be joined by a fishery technologist to advise on the programs of work to be undertaken in fishery technological laboratories. In connection with the country's development program for the Amazon Basin [*see FAO Fisheries Bulletin,* VII (4), 187], a fishery specialist will initiate a survey of possibilities in inland fisheries and fish culture.

Burma. Dr. S.W. Ling (China), during his visit to Headquarters in December, completed his report on the possibilities of developing pond fish culture. Further visits by a fish culture expert are contemplated in 1955, amounting in all to a period of four months in the country, for the purpose of initiating practical field work based on Dr. Ling's recommendations.

Ceylon. Einar Kvaran (Iceland), at his own expense, paid a short visit to Madras in August to confer with FAO/ETAP experts Messrs. Illugason and Ziener, who are working on analogous problems in southern India. The exchange was of great benefit to the program of gear technology and small craft mechanization in both countries. Mr. Kvaran resumed his work in developing shore and maintenance facilities for the seven powered vessels owned and operated by the Department of Fisheries. He also carried out further field work on the beach seine winch which, at the suggestion of the Ministry of Fisheries, will be tried out at several points along the coast in order to develop a design adapted to all foreseeable working conditions. He was joined on 9 November by Jon Saemondsson (Iceland) who, after briefing in Rome and a stay of two weeks with Mr. Illugason, in Madras, has assumed duty in succession to A. Glanville as a fishery engineer. Both projects will continue throughout 1955.

Dr. S.W. Ling (China), after completing his mission in Thailand, will assume duty in Ceylon early in January to initiate a program for the development of the island's inland fisheries and fish culture.

A fellowship in marine engineering will be provided in 1955.

Chile. Karl Olesen (Denmark) has completed two extensive tours of important fishing centers, one to the north and one to the south of Valparaiso, and on the basis of his findings has now defined his program of work. He is impressed with the possibilities of introducing improved methods for catching tuna and allied species, and of hauling mechanically bottom set long lines, which in Chile are sometimes set in very deep water. These heavy lines may take the combined efforts of four men to haul back on board, and the introduction of powered line haulers would appear to be a very profitable field of experiment. He was joined in November by N.P. Hansen (Denmark), fish handling technologist, who is working on improved fish distribution practices. Both experts will continue their program of work throughout 1955.

The report on Dr. F. de Buen's fishery biological project is in preparation.

A. Bories, Fellow in fish handling and processing, after studying in the United Kingdom, Iceland and the Netherlands, is now in Western Germany ; later he will visit Denmark and Norway. His program of work is designed to give wide experience in fish processing.

M. Montt, Fellow in fishery economics, has concluded his fellowship with a visit to Spain. Following this he conferred with fishery officers in Rome before returning to Chile.

Professor N. Bahamonde has been awarded a fellowship in fishery biology and will undertake advanced training in Scandinavia.

Colombia. V. Paz-Andrade (Spain), after briefing in Rome, will assume duty in January on a four-month assignment. He will advise on strengthening and improving the organization of the Fisheries Department of the Ministry of Agriculture, in order to secure effective administration of a well planned fishery program.

Costa Rica. Martin Burkenroad (U.S.A.), fishery biologist, visited Costa Rica for several weeks in September from his base in Panama and outlined a program of work with the Fishery Department of the Government to investigate the shrimp resources. Working facilities were made available in Puntarenas by the Inter-American Tropical Tuna Commission. The expert paid a second visit to the country in November and further visits will be arranged during 1955.

A fellowship in shrimp biology will also be provided in 1955.

Curaçao (Netherlands Antilles). A fishery consultant will visit Curaçao for three months in 1955 to assist the Government in formulating a fishery development program including the establishment, if found desirable, of a trawling industry. As a preliminary step towards this undertaking, J. d'Alarção of the Economics and Statistics Branch at Headquarters visited Curaçao in November to enquire into the problems which may be retarding fishery development.

Denmark. FAO has been invited by the Government of Denmark to join with them in conducting a training center in Denmark designed primarily for fishery administrators from certain underdeveloped countries. The center will begin in August 1955 and last for six weeks. It will be financed mainly from a special supplemental education grant provided by the Danish Government; FAO will provide the co-director of the Center, who will also assist with instruction. Advantage will be taken of the modern, well organized fishery undertakings and of the highly developed government fishery services, to demonstrate to participants the organization and methods by which governmental fishery administration serves the immediate needs and promotes the development of commercial fisheries. Courses in fishery biology, the technology of fishing craft and gears, fish handling, utilization and transport, fisheries statistics and economic research in production and marketing, will be designed to explain to participants the significance of the work in these fields and how the results are coordinated and used by the fishery administrator in planning fishery development. It is hoped to attract a fairly homogeneous group of participants with comparable educational background. The courses will be conducted in English.

Dominican Republic. The report of S.Y. Lin (China) on his fish culture project in the Dominican Republic is under review at Headquarters.

Ecuador. Karsten Hoydal (Denmark) has established his headquarters at Manta, and is engaged in assisting the Government with the construction of a fish meal plant. At the same time he is developing a technique for salting pinchagua (thread herring) in barrels for a trial shipment up-country to Quito. He is also advising and assisting the Government in the erection of a fish freezing and salting drying plant. Mr. Hoydal will continue this program throughout 1955.

The report on Dr. E. Schweigger's fishery biological project is in the final stages of editing.

G.J. Mignone, the counterpart assistant working with Mr. Hoydal, has been awarded a fellowship in fishery technology for study in Canada during 1955.

C. Reyes-Vandenberg, Fellow in fishery biology, concluded his studies at La Rochelle, France, in December.

Egypt. K.W. Jensen (Norway) assumed duty as inland fishery biologist in Egypt on 18 October. He has established his headquarters in Alexandria and is developing a co-operative project with the Fuad I Hydrographic Institute to assess the fundamental productivity of a large artificial sheet of water known locally as the hydrodrome. The outcome of this project is likely to influence policy on the development of inland fisheries and fish culture in Egypt, and may provide an estimate of the productivity which may be expected in similar controlled waters. Some difficulty is being experienced in recruiting a statistician with suitable experience to assist the Government in reorganizing the systems for the collection and collation of fisheries statistics. Both posts will continue through 1955.

A fellowship in fishery biology and another in fisheries statistics will be provided in 1955.

Finland. D.A.L. Wikstrom, Fellow in fishery administration, concluded his studies in October, having visited Norway, Western Germany, Sweden, Denmark and the Netherlands.

E.T. Kajosaari, Fellow in fish protection and pollution problems, returned to Finland in October, after studies in the United Kingdom and Sweden. Many different aspects of fresh water pollution and the influence of dams and barrages on migrating fish were examined.

Guatemala. S. Y. Lin (China) visited Guatemala for two weeks in October and returned again in December for a 3 months' stay in order to carry out a general survey of the development possibilities in the inland fisheries and fish culture. He is carrying out this mission in conjunction with similar work in Honduras. The joint project will continue throughout 1955.

Haiti. Shimon Tal (Israel) visited Headquarters in October and completed his report, which is being edited prior to submission to the Government. He left behind him in Haiti two main continuing activities ; firstly, the rough release of carp and Tilapia which has resulted in the establishment of river fisheries throughout the country, these fish now being commonplace on up-country markets and a significant contribution to the diet and well-being of rural populations ; and, secondly, carp culture in ponds with the Israeli strain of carp which has now been established as a profitable commercial activity near Port-au-Prince, where there is a keen demand for large table fish. Government-trained counterpart workers are continuing with this project.

Soon after Mr. Tal's departure, the hurricane " Hazel " caused extensive damage to the fish culture stations which at first sight appeared to be crippling. The station staff, however, worked energetically in the aftermath of the storm and managed to salvage breeding adults of valuable fish and some stocks of fingerlings. It is hoped that it

will be possible to re-establish the full program of breeding and rearing stocks for supply to fish farmers by the summer of 1955.

Provision has been made in 1955 for a three-month assignment of a marine fishery engineer to assist in reviewing the possibilities of improving the efficiency of the inshore fisheries.

Honduras. S.Y. Lin (China) has completed his preliminary survey of the inland fisheries resources, and has prepared a detailed report with recommendations for the development both of the inland fisheries and of fish culture in ponds. This report is under review at Headquarters and will form the basis, after submission to the Government, of a program of work to be undertaken by Mr. Lin from March 1955 to continue throughout the year.

Hong Kong. Following the conclusion of the First FAO International Fish Marketing Training Centre in August, a program was put into operation to assemble the lecture material and the summaries of the seminar discussions and prepare them for publication in 1955. This task has been undertaken by Mr. Szczepanik (U.K.), Lecturer in Economics of the Hong Kong University, with the co-operation of Mr. J.T. Wakefield, Director of the Co-operative and Marketing Department, Hong Kong Government. The completed work should prove valuable for reference purposes for all those concerned with fish marketing problems throughout Asia and the Far East. Meanwhile a report is in preparation on the organization and administration of the Centre.

India. Paul Ziener (Norway) has completed the present phase of his work in the State of Madras and has returned to Bombay. The main outcome of his work in Madras has been the construction of a motor surf boat to his design by the Government of Madras. Sea trials of this vessel, including passages through the surf, have been most encouraging, although the builders did not follow his design in all respects. The experience gained with this experimental vessel has resulted in a second design which, if built, is likely to become the prototype of an extremely useful craft which might revolutionize fishing from the hundreds of miles of surf-bound coasts of the States of Madras and Andhra, as well as in Travencore-Cochin and Orissa. There are some 21,000 catamarans along this coast, which might eventually be replaced by motor surf boats. These craft will be designed to pass through the surf; they are not beach landing craft, as such.

Mr. Ziener has also advised the Government of Madras on the installation of engines furnished by the U.S. Foreign Operations Administration (FOA) in small local craft, and has co-operated closely with the fishery officers of FOA on problems of fishing craft design which have been referred to him. In Bombay, he is developing the design of small craft which might continue fishing operations during the heavy weather of the monsoon, and is now working on a combined program in the States of Bombay and Saurashtra, where both Governments have vigorous fishing craft construction programs.

Meanwhile, G. Illugason (Iceland), who is working on both coasts of the State of Madras, has co-operated closely with Mr. Ziener, especially in the sea trials of the motor surf boat. He has also been engaged in introducing improvements in drift nets, small purse seines, and small trawls ; and is introducing net chutes, line haulers, nylon drift nets, a lampara, hand-winches for beaching and hauling up small craft, and shark long lines. Not only are fishing methods becoming more efficient and successful, but local fishermen are being trained in their use. This very full program has been made possible only because Mr. Illugason has the full co-operation and support of the Directorate of Fisheries.

The report on H. van der Heyden's (Netherlands) fishing project in West Bengal is in preparation.

The program for 1955 in India includes the continuation of the missions of Messrs. Ziener and Illugason. In addition, the following new experts will assume duty ; a fishery engineer in the State of Saurashtra (6 months) ; a fish harbor specialist (12 months) ; a fishery specialist to organize a center for the training of master fishermen (12 months) ; a fishery technologist to advise on the research programs of fishery technology laboratories (6 months) ; and a fish culture biologist for the State of Orissa (12 months).

A fellowship in fishery economics may be provided in 1955.

Indonesia. An expert is being recruited to serve throughout 1955 to help the Government in strengthening their inland fishery extension service by undertaking a special training program in the theory and practice of inland fisheries and fish culture.

A Third International Training Center in Pond Fish Culture, the second organized by FAO, will be held in Indonesia by invitation of the Government in the autumn of 1955. The first Center was organized by the Government of Indonesia.

Iran. Harald Fibiger (Denmark) sailed from Aden on 3 December in the FAO tuna fishing vessel *New Hope* which has been extensively refitted. He arrived in Bandar Abbas on 18 December, having been accompanied part of the way by the Government of Aden's motor fishing vessel *Britsom*. Mr. Fibiger, with the *New Hope*, is carrying out exploratory fishing operations in the Gulf of Oman and the Persian Gulf for tuna and sardines, and will also undertake some shrimp trawling. This is a joint enterprise between the Ministry of Agriculture of Iran, the Iran/American Joint Fund for Agriculture, FOA in Iran and FAO.

Iraq. A. van den Eelart (Netherlands), who completed a preliminary survey in 1952/53 of the possibilities for inland fishery development, returned to duty in Iraq on 8 November to assist the Government in formulating a program to put some of his recommendations into effect. He will remain in Iraq throughout 1955.

The report on the fishing project in the Persian Gulf by G. Amodeo (Italy) is in preparation.

Israel. A fellowship will be provided in the 1955 program for the study of the methodology of training sea fishermen. This is in

conjunction with the middle and distant water fisheries development program involving a new fleet of trawlers being built in Germany for the Israeli Government.

Jamaica. The report prepared by Shimon Tal (Israel) on the development possibilities in inland fisheries and fish culture has been forwarded to the Government. There appear to be extensive possibilities for pond culture, also in the rough release of suitable species in natural waters.

Liberia. Knud Fredriksen (Denmark) assumed duty in Liberia on 16 December after briefing in Rome. He is continuing as a fishery engineer to develop the program of small craft mechanization initiated by H. van Pel (Netherlands) at various points along the Liberian coast, using the 24-foot Danish-built fishing boat supplied by FAO.

Libya. It is believed that the fisheries of the shelf off the coast of Libya have potentialities for development on a commercial scale, and a fishery consultant will work throughout 1955 to carry out a reconnaissance survey on the availability of fish stocks in the adjacent Mediterranean waters, and to formulate a development program if the indications should be favorable.

Mexico. John Fridthjof (Denmark), after completing his assignments in Chile and Yugoslavia, assumed duty in Mexico on 1 November and is carrying out a program of education and publicity to increase the consumption of locally caught fish, and develop new domestic markets for local fish products. It is expected that this project will continue until the autumn of 1955. Mr. Fridthjof will also investigate, in conjunction with the Nutrition Division of FAO, the possibilities of promoting the consumption of fish flour manufactured by two or three different processes.

The *Second Latin American Fisheries Training Center* was held in Mexico from 4 October to 10 December 1954. This Center, with a faculty of some 18 lecturers provided by the Government of Mexico and FAO, was attended by 46 participants from 14 Latin American countries. Mr. Manuel Torres Torija of Mexico served as Director of the Center and Dr. B.F. Osorio-Tafall, FAO Regional Fisheries Officer for Latin America, acted as Associate Director.

The first four weeks, spent in Mexico City, were devoted to intensive lecture courses on fishery administration, biology, technology and economics. Through arrangements generously made by the Mexican Government, the entire party of instructors and participants then spent five weeks visiting important fishing centers on both coasts of Mexico, where they saw in operation a wide variety of fishing installations, vessels, harbors, canneries, cold stores, fish meal plants, markets, and research laboratories. On-the-spot demonstrations were given by Mexican and FAO-recruited instructors so that the participants, mostly fishery administrators, could make the most of their opportunities for appreciating how the many problems encountered in fishery development are resolved in practice. The last three weeks were spent once again in Mexico City in seminars and discussions.

during which each participant prepared and communicated to his colleagues an account of what he had observed in his own field of interest, with special reference to its application to the problems in his own country.

Pakistan. The report on the work of Messrs. Magnusson and Ohlsson on fishing boat design is in preparation.

Panama. The fishery laboratory, the Laboratorio Nacional de Pesca, Panama, established by the Government at the suggestion of fishery biologist Martin Burkenroad (U.S.A.), has now been staffed with a nucleus of workers and a program of biological research on the shrimp fishery has been launched. The main purpose of this program is to undertake a general investigation of the shrimp stocks. In addition, one or two other studies have been undertaken, for instance, the capture and drying of small shrimps for local consumption. Material is being assembled on the abundance of shrimp, and this problem and that of shrimp distribution is becoming more defined. The report on Mr. Scattergood's preliminary shrimp investigations is in the final stages of editing.

A fellowship in shrimp biology will be provided in 1955.

Paraguay. The twice postponed project to review possibilities for development of inland fisheries in Paraguay will be undertaken in 1955, starting in the latter half of the year.

Saudi Arabia. G. G. Ferrer, (Philippines) fishery engineer, has carried out some experimental fishing, and has found distinct possibilities in trolling for tuna and kingfish. FAO has provided him with some lamps, lures, and other gear so that he may experiment further with multiple trolling and attempt some night fishing for sardines with lampara nets or Phillipine-style lift nets. Mr. Ferrer's assignment will continue throughout 1955. The report on the fishery exploratory surveys carried out in the Red Sea in 1953 by Dr. M. K. el Saby and L. Farina is in preparation.

Syria. Two projects are planned for 1955. The first will consist of a reconnaissance survey by a fishery engineer over three months, to determine whether larger scale exploratory operations at sea would appear to be worthwhile; and the second, a survey by a fish culturist in the latter part of the year to institute a program of inland fisheries development, the possibilities of which, at first sight, appear to be promising.

Thailand. Dr. S.W. Ling completed the last phase of his long and highly effective inland fisheries and fish culture assignment, and prepared his final report at Headquarters in December. His recent activities have included a search for Chanos fry ; an investigation of one or two local species of fish for their suitability for pond culture ; the shipment of fingerling fish to Laos and Egypt; and a continuation of the Thai Fishery Department's well developed program for rough release and stocking material to fish farmers, deliveries of the latter being maintained at a level of approximately 450,000 fingerlings per month.

In 1955, investigations will be continued by another expert in the specialized field of Chanos (milk fish) fry capture and distribution and rearing of market-size fish.

Dr. Ling's visit to Indonesia [*see FAO Fisheries Bulletin* VII (4), 191-192] with a number of Thai fishery officers, arranged by the Government and the Foreign Operations Administration (FOA), was informative. The party visited centers where many different practices in pond culture were being followed, namely, rice paddy fish culture, tambaks and fry marketing, and they also surveyed the pond culture extension services.

Dr. Ling also visited Tokyo in October to present a paper on "The Use of Rice Fields for Fish Culture" at the 4th Session of the International Rice Commission. This paper was prepared by W.H. Schuster, formerly of FAO Headquarters staff (*see* pp. 39-41).

Turkey. Olav Aasen (Norway), in the latter part of the year, carried out several exploratory voyages in the Government's research vessel *Arar*, in which an Asdic of Norwegian design, especially adapted for fish searching, has been installed on Mr. Aasen's recommendation. On her first voyage, and again subsequently, the Asdic picked up considerable schools of pelamut (bonito, *Sarda sarda*) under conditions in which twin-boat local style, or single boat Pacific coast style purse seines could be applied effectively. The fishing side of the work will be developed further when the fishery engineer, now being recruited, arrives. Both Mr. Aasen and the fishery engineer will continue their work throughout 1955.

In October, H. Henriksen (Norway) completed his assignment concerned with various economic fishery problems. He has been unable to continue with this work because his Government could not extend his leave of absence. His report has been completed and will shortly be forwarded to the Government of Turkey. Recruitment is in progress to locate a replacement for Mr. Henriksen for duty throughout 1955.

The report on the fishing project of G.S. Napier (U.S.A.) is in preparation.

C. Renda, Fellow in fish marketing, has been working in Denmark, Norway, and the United Kingdom, on a study of various econnomic and social measures in marketing fish products.

E. Akyuz, Fellow in fishery biology, having completed his studies at the Lowestoft Fisheries Laboratory, England, carried on further studies at the Oceanographic and Fishery Institute, Split, Yugoslavia. He returned home in November.

Three fellowships will be provided in 1955, namely, in fishery biology, fishery economics, and fishing gear technology.

Yugoslavia. Knud Fredriksen, Danish fishery engineer, carried out a two-month assignment in October and November before taking up duty in Liberia. He was in time for the current fishing season and in early December handed over to Sigurd Nielsen (Denmark), who arrived in Yugoslavia on 24 November on a four-months' assignment.

These two fishery engineers have been working from Split on mid-water trawling, long-lining, and bottom trawling in deep water.

The report on J. Fridthjof's work to expand fish consumption is in preparation.

J. Simoncič, Fellow in fish handling and refrigeration, after his visit to French North Africa, was obliged to conclude his studies in Denmark prematurely owing to a serious car accident.

H. Lisac, Fellow in fish processing technology, is continuing his studies begun in Denmark, at the Bundesforschungsanstalt für Fischerei in Hamburg; he returns home in January 1955.

Mrs. Mihajlovič-Babuder, Fellow in fish pathology, is continuing her studies on fish diseases at Erlangen, Germany, under Professor W. Wunder, former FAO/ETAP expert in Yugoslavia.

Five fellowships will be provided in 1955 in fisheries economics, fishing gear, fish processing, and net making.

Equipment, ETAP Program 1955. Equipment to the value of U.S.$49,050 is provided for in the Category I program.

Category II Program for 1955

The Category II program, to be implemented if additional funds become available, includes 14 posts and five fellowships. Of these, seven posts and three fellowships are in fishery technology, four posts and one fellowship in fishery biology, and three posts and one fellowship in fisheries economics. Equipment to the value of U.S.$10,000 is provided for in this program.

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General

Activities of FAO under the Expanded Technical Assistance Program

1950/52

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Current Fisheries Literature

New Publication

Indian Journal of Fisheries. Government of India Central Marine Fisheries
1954 Research Station, Mandapam Camp P. O., S.I. Rly., South India.
Vol. 1, Nos. 1/2. Price of issue : 7 Rs. 8 As.

The purpose of this new periodical is to provide a medium for the publication of original contributions and critical reviews in fisheries research and would cover subjects relating to fishery biology, fishery technology and other scientific topics of direct and indirect bearing on the development of fisheries science in general and of Indian Fisheries in particular.

The Editorial Board consists of the Fisheries Development Adviser to the Government of India (Chairman), the Chief Research Officer, Central Inland Fisheries Research Station and the Chief Research Officer, Central Marine Fisheries Research Station (Managing Editor).

Its scope is perhaps best illustrated by listing the contents of the first issue, which were as follows :

R. Raghu Prasad. "The Characteristics of Marine Plankton at an Inshore Station in the Gulf of Mannar, near Mandapam."

K. Virabhadra Rao. "Biology and Fishery of the Palk-Bay squid *Sepioteuthis arctipinnis* Gould."

K. K. Sarojini. "The Food and Feeding Habits of the Grey Mullets, *Mugil parsia* Hamilton and *M. speigleri* Bleeker."

M. S. Prabhu. "The Perch Fishery by special Traps in the Area Around Mandapam in the Gulf of Mannar and Palk Bay."

V. Krishna Pillai. "Growth Requirements of a Halophilic Blue-green Alga, *Phormidium tenue* Menegh."

G. Seshappa and B. S. Bhimachar. "Studies on the Age and Growth of the Malabar Sole *Cynoglossus semifasciatus* Day."

K. Gopinath. "A Note on some Deep Sea Fishing Experiments off the South-western Coast of India."

R. Subrahmanyan. "On the Life History and Ecology of *Hornellia marina gen. et sp. nov.*, (Chloromonadineae), causing Green Discoloration of the Sea and Mortality among Marine Organisms off the Malabar Coast."

Santimoy Banerjea and Eva Mitra. "Preliminary Observations on the Use of Copper Sulphate to Control Submerged Aquatic Weeds in Alkaline Waters."

N. K. Panikkar and P. R. S. Tampi. "On the Mouth-breeding Cichlid, *Tilapia mossambica* Peters."

A. David. "A Preliminary Survey of the Fish and Fisheries a Five Mile Stretch of the Hooghly River near Barrackpore.

S. Jones and K. H. Sujansigani. "Fish and Fisheries of th Chilka Lake with Statistics of Fish Catches for the Years 194 1950."

R. Jayaraman. "Seasonal Variations in Salinity, Dissolved Oxyge and Nutrient Salts in the Inshore Waters of the Gulf of Manna and Palk Bay near Mandapam (S. India)."

Finally, there are articles about each of the important fisheries researc stations in India, giving a short account of their history, of their prese facilities and work, lists of publications, and the names of the staff.

TIPOGRAFIA FAUSTO FAILLI - ROMA